(29,265)

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1922.

No. 715.

ELECTRIC BOAT COMPANY, APPELLANT,

vs.

THE UNITED STATES.

APPEAL FROM THE COURT OF CLAIMS.

INDEX.

JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., FEBRUARY 5, 1923.

1 **I. PETITION AND EXHIBIT "A."**

[Filed July 29, 1914.]

In the United States Court of Claims.

No. 32877.

ELECTRIC BOAT COMPANY, Petitioner,
against
THE UNITED STATES OF AMERICA, Defendant.

To the Honorable the Judges of the Court of Claims:

The petition of Electric Boat Company respectfully represents:

1. That it is a body corporate organized and existing under the laws of the State of New Jersey, having a manufacturing establishment at Groton, Connecticut, and having an office at No. 5 Nassau Street, New York, N. Y.

2. That on August 20, 1912, Letters Patent of the United States for improvements in Automobile Torpedoes, No. 1,036,082, were duly granted to your petitioner as assignee of Gregory C. Davidson, whose application therefor was duly filed March 19, 1908, and renewed July 3, 1912; and that said Letters Patent granted to your petitioner the exclusive right to make, use and sell throughout the United States and the territories and possessions thereof, the
2 invention therein described and claimed, for the term of seventeen years from the date thereof.

3. That the said Gregory C. Davidson was the original, first and sole inventor of the said improvements described and claimed in said Letters Patent; that the said invention was not known or used by others prior to his invention or discovery thereof and was not patented or described in any printed publication in this or any foreign country prior to his invention or discovery thereof or more than two years prior to his application for said Letters Patent; that the said invention was not in public use or on sale in this country for more than two years prior to the date of his application for said Letters Patent and was not patented in any country foreign to the United States on an application filed more than twelve months prior to the date of his application for said Letters Patent and was not abandoned by him; that the application for said Letters Patent was duly assigned to your petitioner before the issuance of said Letters Patent by an assignment in writing duly recorded in the Patent Office; and that said Letters Patent were in all respects duly issued and delivered to your petitioner in conformity with the laws of the United States.

4. That on August 20, 1912, Letters Patent of the United States for improvements in Apparatus for Generating Motive Fluid for

Automobile Torpedoes, Nos. 1,036,080, were duly granted to your petitioner as assignee of said Gregory C. Davidson, whose application therefor was filed March 29, 1909; and that said Letters Patent granted to your petitioner the exclusive right to make, use and sell throughout the United States and the territories and possessions thereof the invention therein described and claimed for the term of seventeen years from the date thereof.

3 5. That the said Gregory C. Davidson was the original, first and sole inventor of the said improvements described and claimed in said Letters Patent, No. 1,036,080; that the said invention was not known or used by others prior to his invention or discovery thereof and was not patented or described in any printed publication in this or any foreign country prior to his invention or discovery thereof or more than two years prior to his application for said Letters Patent; that the said invention was not in public use or on sale in this country for more than two years prior to the date of his application for said Letters Patent and was not patented in any country foreign to the United States on an application filed more than twelve months prior to the date of his application for said Letters Patent and was not abandoned by him; that the application for said Letters Patent was duly assigned to your petitioner before the issuance of said Letters Patent by an assignment duly recorded in the Patent Office; and that said Letters Patent were in all respects duly issued and delivered to your petitioner in conformity with the laws of the United States.

6. That by virtue of the assignments aforesaid, your petitioner became, has ever since been and now is the sole and exclusive owner of said Letters Patent Nos. 1,036,082 and 1,036,080, and of the inventions and improvements therein described and claimed, including all claims for damages for infringement of said Letters Patent from the time of the grant thereof, and except for the grant of a license as hereinafter set forth, your petitioner is now the sole and exclusive owner of all rights secured by said Letters Patent and each of them since the date thereof.

4 7. That prior to the issuance of said Letters Patent, all proceedings were duly had and taken which were required by law to be had and taken previous to the grant of said Letters Patent.

8. That the inventions set forth in said Letters Patent Nos. 1,036,082 and 1,036,080 are adapted for and capable of conjoint use in one and the same apparatus, and that in the apparatus hereinafter complained of they are so conjointly used.

9. That the inventions described and claimed in said several Letters Patent and each of them are and have been recognized to be of great utility and value in the construction and operation of automobile torpedoes; and that since the grant of said Letters Patent on August 20, 1912, your petitioner, in the exercise of the exclusive rights so granted, has been ready and willing to make and vend automobile torpedoes employing the inventions set forth in said several Letters Patent and to grant to others the right to make, use and vend the improvements so patented.

10. That on April 3, 1912, your petitioner entered into an agreement in writing with the United States, a copy of which is annexed hereto and marked "Exhibit A," in accordance with which agreement the United States was licensed and empowered to manufacture on its own behalf, either in its own shops or by contract in private shops, and to use, automobile torpedoes equipped with steam generators containing the inventions set forth in a certain Letters Patent of the United States and in certain applications for Letters Patent of the United States including the applications for said Letters Patent Nos. 1,036,082 and 1,036,080 to the ends of the terms for which said Letters Patent had been or should be granted, and in return therefor the United States agreed
5 to pay to your petitioner a royalty of One Thousand Dollars ($1,000) for each of the first ten torpedoes, Nine Hundred Dollars ($900) for each of the second ten torpedoes, and Eight Hundred Dollars ($800) for each of all additional torpedoes made by or for the United States in accordance with the license granted to it and containing the inventions set forth in the Letters Patent and the applications for Letters Patent enumerated in said agreement, including the applications for said Letters Patent Nos. 1,036,082 and 1,036,080, the royalty provided for in the agreement to become payable when each such steam generator for automobile torpedoes had been tested and accepted by the United States.

11. Your petitioner further shows, upon information and belief, that the United States, through its officers and agents, well knowing the premises and the exclusive rights granted to your petitioner as aforesaid under said Letters Patent, has, since the execution of said license agreement on April 3, 1912, and since the grant of said Letters Patent on August 20, 1912, and from time to time thereafter, at various places within the United States, made or used or caused to be made or used, and is now making or using or causing to be made or used, Automobile Torpedoes and Apparatus for Generating Motive Fluid for Automobile Torpedoes embodying the inventions described and claimed in said several Letters Patent, and has neglected and refused to pay royalty to your petitioner, in accordance with the terms of said agreement dated April 3, 1912, or otherwise, though often requested so to do, all in defiance of the rights granted to your petitioner by said Letters Patent Nos. 1,036,082 and 1,036,080, and in disregard of the obligation upon the United States in accordance with the terms of said agreement dated April 3, 1912.

6 12. That as your petitioner is informed and believes, the Government of the United States, through its duly authorized officers and agents, has made or has caused to be made for it Automobile Torpedoes and Apparatus for Generating Motive Fluid for Automobile Torpedoes employing the inventions described and claimed in said Letters Patent Nos. 1,036,082 and 1,036,080 to the number of approximately Two Hundred Forty (240) since the execution of said agreement on April 3, 1912, and since the grant of said Letters Patent on August 20, 1912; that your petitioner is

unable to state with particularity, without an examination of certain records in the Navy Department, either how many Automobile Torpedoes and how many Apparatus for Generating Motive Fluid for Automobile Torpedoes employing the inventions set forth in said several Letters Patent have been made by or for the United States; and that in order to enable it to state its claim with greater particularity, your petitioner requires access to the records of the purchases of Automobile Torpedoes and Apparatus for Generating Motive Fluid for Automobile Torpedoes from E. W. Bliss Company of Brooklyn, New York, by the Navy Department of the United States and the types of automobile torpedoes so purchased, during the period from April 3, 1912, to the date hereof.

13. That a fair and just compensation to your petitioner for the use of said inventions by the United States as aforesaid is at the rate of One Thousand Dollars ($1,000) for each of the first ten torpedoes, Nine Hundred Dollars ($900) for each of the second ten torpedoes, and Eight Hundred Dollars ($800) for each additional torpedo containing or employing the inventions described and claimed in said Letters Patent, or either of them, making a
7 total of One Hundred and Ninety-Five Thousand Dollars
($195,000) for the said Two Hundred Forty (240) torpedoes, the same being substantially the value of said inventions and the value which your petitioner attributes to the use of said inventions and the value which the United States obligated itself to pay to your petitioner by the said agreement dated April 3, 1912.

14. That your petitioner is the sole owner of the claim set forth in this petition, no assignment or transfer of the said claim or any interest therein having ever been made; and that your petitioner is justly entitled to the amount hereafter claimed from the United States after allowing all just credits and off-sets.

15. That no action upon your petitioner's claim has been had by or before Congress or any executive department of the Government of the United States, and no proceeding is now pending in any Court directed to a settlement of said claim.

16. That at the times of applying for and of the issuance of said several Letters Patent, the said Gregory C. Davison was a citizen of the United States; that he has at all times borne true allegiance to the Government of the United States, and that neither the said Davison nor your petitioner has ever in any way voluntarily aided, abetted or given encouragement to rebellion against the United States; and that said Davison was not, at the times when he made the said inventions, in the employment or service of the Government of the United States.

17. That the facts stated in this petition are true.

Wherefore, your petitioner asks judgment in its favor against the United States for the sum of One Hundred and Ninety-Five
8 Thousand Dollars ($195,000) as royalty payable to your
petitioner in accordance with the terms of said agreement of April 3, 1912, and as compensation for the use of the inventions set forth in said Letters Patent Nos. 1,036,082 and 1,036,080 under Act of Congress of June 25, 1910.

Your petitioner's address is No. 5 Nassau Street, New York, N. Y. The address of its attorney, Norman Johnson, Esq., is No. 5 Nassau Street, New York, N. Y. Electric Boat Company, by Elihu B. Frost, Vice-President. Norman Johnson, Solicitor for Petitioner, No. 5 Nassau Street, New York City. Pennie, Davis & Goldsborough, Counsel for Petitioner, No. 35 Nassau Street, New York City.

9 STATE OF NEW YORK,
County of New York, ss:

Elihu B. Frost, being first duly sworn, deposes and says that he is Vice President of Electric Boat Company, the petitioner and plaintiff named in the foregoing petition; that he has read said petition and knows the contents thereof; that the same is true to his own knowledge save in so far as the averments thereof are stated to be based upon information and belief, and as to those averments he believes it to be true; and that he verily believes that Gregory C. Davison was the original, first and sole inventor of the improvements in Automobile Torpedoes set forth in said Letters Patent No. 1,036,-082, and the improvements in Apparatus for Generating Motive Fluid for Automobile Torpedoes set forth in said Letters Patent No. 1,036,080, referred to in said petition. Elihu B. Frost.

Subscribed and sworn to before me this 27th day of July, 1914. Augustus Treadwell, Notary Public, Kings Co., No. 137. Certificate filed in N. Y. County, No. 33.

10 **EXHIBIT "A."**

Shop License.

This agreement, made this 2nd day of April, 1912, by and between the Electric Boat Company, a corporation organized under the laws of the State of New Jersey, party of the first part, and the United States, party of the second part, witnesseth:

That, whereas, the said party of the first part is the owner of the invention known as Steam Generator for Automobile Torpedoes covered by

Application Serial No. 422,175, dated March 9, 1908.
Application Serial No. 486,455, dated March 29, 1909.
Application Serial No. 590,627, dated Nov. 10, 1910.
U. S. Patent Serial No. 980,243, dated Jan. 3, 1911.

And whereas, the said party of the second part is desirous of securing certain manufacturing rights with respect to said invention:

Now, therefore, the said parties hereto have agreed and do hereby agree as follows:

1. The said party of the first part hereby licenses and empowers the said party of the second part to manufacture for and on behalf of the said party of the second part either in its own shops or by

contract in private shops and to use torpedoes equipped with Steam Generator for Automobile Torpedoes covered by

Application Serial No. 422,175, dated March 9, 1908.
Application Serial No. 486,455, dated March 29, 1909.
Application Serial No. 590,627, dated Nov. 10, 1910.
U. S. Patent Serial No. 980,243, dated Jan. 3, 1911.

and any improvements thereon now or hereafter owned or
11 controlled by the party of the first part, subject to the con-
ditions hereinafter named, to the end of the term for which Letters Patent for said invention and any improvements thereon have been or may be granted.

2. The said party of the second part hereby agrees to pay to the said party of the first part in consideration of the license hereby granted a royalty of one thousand dollars ($1,000) for each of the first ten torpedoes equipped with the Steam Generator for Automobile Torpedoes covered by the application for Letters Patent and Letters Patent before mentioned manufactured by the party of the second part under this license, nine hundred dollars ($900) for each of the second ten torpedoes so equipped manufactured under this license by the said party of the second part, and eight hundred dollars ($800) for each additional torpedo so equipped manufactured under this license by the said party of the second part, no royalty to be paid or payable by the said party of the second part to the said party of the first part under this agreement until each such Steam Generator for Automobile Torpedoes shall have been tested and accepted by the said party of the second part.

3. The said party of the first part will at its own expense defend the said party of the second part and hold it harmless against all and every demand or demands of any nature or kind heretofore made or that shall hereafter be made for or on account of the manufacture for its own use by the said party of the second part in its own shops or by contract in private shops or by reason of the adoption or use by said party of the second part of the device covered by the applica-
tion for Letters Patent and Letters Patent hereinbefore men-
12 tioned, to wit, the Steam Generator for Automobile Torpedoes,
or any improvements thereon now or hereafter owned or controlled by said party of the first part.

4. The said party of the second part hereby agrees to make full and true returns to the said party of the first part, on the first day of January each year of the number of Steam Generators and Automobile Torpedoes therewith manufactured under this license during the preceding year.

5. No member of or delegate to Congress, officer of the Navy nor any person holding any office or appointment under the Navy Department is or shall be admitted to any share or part of this contract or to any benefit to arise therefrom.

6. Nothing in this license-agreement shall be held or construed to interfere with or limit in any wise any present or future right of the party of the first part to manufacture or use the said Steam Generator

for Automobile Torpedoes or any improvement or modification thereof and torpedoes equipped therewith for demonstration or other purposes whatsoever or to sell and dispose thereof.

In witness whereof, the said parties hereto have hereunto set their hands and seals the day and year first above written. Electric Boat Company, by Elihu B. Frost, Vice-President. The United
13 States, By Beekman Winthrop, As Acting Secretary of the Navy. Witnesses: H. Taylor. Harry W. Miller, Solicitor, as to Beekman Winthrop, Acting Secretary of the Navy. (Blue Seal Navy Department United States of America.)

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II. GENERAL TRAVERSE.

No demurrer, plea, answer, counterclaim, set-off, claim of damages, demand, or defense in the premises, having been entered on the part of the defendant, a general traverse is entered as provided by Rule 34.

III. HISTORY OF PROCEEDINGS.

On April 3 and 4, 1919, the case was argued and submitted by Mr. Dean S. Edmonds, for the plaintiff, and by Mr. W. D. Eakin, for the defendant.

On June 28, 1919, the Court filed tentative findings of fact and allowed both parties until Sept. 15, 1919 in which to file objection or suggested changes thereto.

On Sept. 15, 1919, the defendant filed a motion for changes in said tentative findings of fact.

On September 16, 1919, the plaintiff filed a motion to amend tentative findings of fact.

On October 24, 1919, the case was argued and submitted on tentative findings of fact by Mr. Dean S. Edmonds, for the plaintiff, and by Mr. W. D. Eakin, for the defendant.

On April 5, 1920, the Court filed findings of fact and conclusion of law and entered judgment in favor of plaintiff, and remanded case for proof of liability, with an opinion by Campbell, Ch. J.

On June 21, 1920, the defendant filed a motion for a new trial.

On October 13, 1920, the defendant's motion for a new trial was argued and submitted by Messrs. J. Edgar Bull and F. L. Emery, for the defendant, and by Mr. Dean S. Edmonds, for the plaintiff.

On November 15, 1920, the Court filed an order allowing in part and overruling in part defendant's motion for a new trial,
15 setting aside and withdrawing conclusion of law, judgment and opinion, and filing a new opinion by Chief Justice Campbell.

On September 29, 1921, on motion made therefor, Messrs, Pennie, Davis, Marvin & Edmonds, were substituted as attorneys of record—Norman Johnson, the former attorney, consenting thereto.

IV. FINAL ARGUMENT AND SUBMISSION OF CASE.

On October 4, 1921, the case was argued and submitted by Mr. Dean S. Edmonds, for the plaintiff, and by Mr. J. Edgar Bull, for the defendant.

V. HISTORY OF FURTHER PROCEEDINGS.

On April 3, 1922, the Court filed findings of fact and conclusion of law dismissing petition and entered judgment against plaintiff for the cost of printing in the sum of $605.34, with a Per curiam opinion.

On May 18, 1922, the plaintiff filed a motion to amend the findings of fact filed April 3, 1922.

On May 25, 1922, the defendant filed a motion to amend and supplement the findings of fact filed April 3, 1922.

16 VI. ORDER OF COURT ENTERED JUNE 26, 1922.

This cause coming on to be heard upon the plaintiff's motion and also upon the defendant's motion to amend findings it is ordered by the Court that each of said motions be allowed in part and overruled in part. The former findings are withdrawn and new findings are this day filed. The petition is dismissed. Opinion Per Curiam. By the Court.

17 VII. FINDINGS OF FACT, CONCLUSION OF LAW, OPINION PER CURIAM, AND EXHIBITS I, II, III TO THE COURT'S FINDINGS. ENTERED JUNE 26, 1922.

This case having been heard by the Court of Claims, the court, upon the evidence, makes the following

Findings of Fact

I.

The plaintiff is a corporation, organized and existing under the laws of the State of New Jersey.

II.

On March 29, 1909, Gregory C. Davison, then an employee of the plaintiff, filed in the United States Patent Office an application, Serial No. 486,455, for letters patent for certain improvements in apparatus for generating motive fluid for automobile torpedoes.

III.

For a number of years immediately prior to January 1, 1908, the said Gregory C. Davison was an assistant inspector of ordnance in the United States Navy, in charge of torpedo experiments and development. On said date of January 1, 1908, some three months after his return from an extended European trip for torpedo investigation for the Government said Davison resigned from the United States service and entered the employ of the plaintiff, having charge of torpedo experimental and development work for the plaintiff. Throughout his work as such experimental officer for the Government, including his European trip, Davison kept private notes upon torpedo development, and when he left the Government service he retained such private notes in his possession.

IV.

The general practice in the propulsion of automobile torpedoes has been to employ compressed air for the motive power, and this agency for propulsion has undergone an evolution through the follow-
18 ing stages: First, the use of cold compressed air from a storage chamber located in the torpedo, and thence supplied through a reducing valve to the propelling engine; second, the use of the "inside superheater," consisting of a burner, or heater, located in the compressed-air storage chamber, to heat the air therein during the run of the torpedo; third, the use of the "outside superheater," consisting of a combustion chamber on the low-pressure side of the reducing valve in the conduit for carrying air from the storage chamber to the engine, and so arranged as to have liquid fuel admitted and burned within it to heat the air prior to its admission to the engine; and in recent years a fourth stage, namely, the use of steam in combination with the compressed air and gases of combustion as motive power, the steam being generated and combined with the air and the gases of combustion in a combustion chamber located on the low-pressure side of the reducing valve in the conduit for conveying the air from the storage chamber and arranged to have the air, fuel, and water supplied to it where the fuel and the oxygen in the air are ignited and burned and the water converted into steam by the hot products of the combustion.

The automobile torpedoes used by the United States Navy in 1907 and 1908 were of the type having the "inside superheater," and attained a range of about 3,000 yards. In 1909 the Navy obtained torpedoes which were equipped with the "outside superheater," and attained a range of about 4,000 yards.

By the use in the United States Navy of steam as a part of the motive power, as above described, the range attained has been double that attained with the torpedoes equipped with either the "inside superheater" or the "outside superheater."

V.

One of the chief efforts of those interested in the manufacture and use of torpedoes had been the effort to increase the effective range of this instrument of warfare; and in March, 1908, the attention of the Bureau of Ordnance of the Navy Department was directed to an article in the Revista Maratima Brazileira published in January, 1908, and constituting Exhibit C-14 to these findings of fact, which described the torpedo power plant of the Gesztesy patent constituting Exhibit C-13 to these findings, which power plant provided for the generation and use of steam in combination with compressed air and the gases of combustion for motive power.

On March 26, 1908, this article was forwarded by the Bureau of Ordnance to the E. W. Bliss Company, a commercial firm then manufacturing torpedoes for the Navy, for the company's attention. The Bliss Company on April 4, 1908, returned the article to the bureau with a statement that the company had for some time "had plans on the same general principle as that shown" in the article, and that while it believed there were inherent difficulties against the operation of such a system, it intended at as early a date as possible to make certain tests of it.

On April 17, 1908, the Bureau of Ordnance requested the Bliss Company to inform it of the results of any experiments the company might make with a "superheater of this type," in response to
19 which the company on June 9, 1908, replied that it had as
yet made no progress with such experiments, as its testing facilities were so fully occupied with torpedoes under way for the bureau that it could not then conduct any outside experiments, and that it would report to the bureau the results of any experiments it should make.

Beginning in November, 1909, experiments were carried on by the Bureau of Ordnance at the naval torpedo station at Newport for increasing the motive power and range of torpedoes by the use of steam generated by the injection of water into the combustion chamber, where the steam was combined with the compressed air and gases of combustion. In June, 1910, the ordnance engineer in charge of such experimentation officially reported that in view of the limit on the permissable heat on account of the melting or burning of the material, or a weakening of the structure of the mechanism, the only recourse for increasing the run of the torpedo (the air charge being fixed) was by adding to the volume of the air; that the problem therefore resolved itself "into that of injecting or otherwise introducing some liquid (water obviously being most suitable) into the heater space, the liquid by its evaporation absorbing the excessive heat and adding its own volume to the volume of the air," more fuel being burned "to give a higher temperature to evaporate more water to add more volume;" and that the final limit to the possible gain in that direction is fixed by the amount of oxygen in the air-chamber charge which can be consumed in supporting combustion. In his report the ordnance engineer stated:

"The best method of introducing the water has yet to be ascertained, and when that is done, a further increase in the size of the heater will correspondingly increase its capacity. * * * In general the effort is being made to produce a torpedo better than the best for present needs, and as free as possible from structural hindrances to changes that will be necessary in case certain apparently possible improvements are made in the future. The present heater is capable of burning 66 per cent alchol, and it burns 75 per cent alcohol with great steadiness and certainty. For the present and until there is produced a torpedo thoroughly reliable in the functioning of all those details which have nothing to do with the heater, it is proposed to use 75 per cent alcohol for fuel and no injection of water."

And in a letter transmitting this report there was included a statement as follows:

"As will be seen from the description, the basic principle of the new design is the attempt to increase the range of the torpedo by the introduction of some liquid, preferably water, into the superheater pot, the excess heat of the combustion of the alcohol or kerosene used as fuel being utilized to vaporize the liquid and increase the volume. Several methods of vaporizing the liquid have been experimented with, varying from spraying the liquid through minute orifices to a method employing the flash boiler principle, in which the liquid is progressively heated during its progress through a coil boiler until it emerges as steam. These experiments have been in progress since November 1, 1909, until the present time."

Also in 1910, verbal information was received by the Bureau of Ordnance from the Bliss Company with reference to experi-
20 ments by the company along the same line; and in a letter of October 14, 1910, said company reported to the bureau as follows:

"As the bureau is probably aware, we have designed a new 21-inch torpedo on the general lines of the Mark VI, with a device added which enables us to inject water into the superheater, and materially increase the efficiency. While we have not yet carried our experiments in this direction to a finish, we have already obtained twenty million foot-lbs. of work out of the Mark III, 21-inch flask full of air, against about ten to eleven million which we develop with the standard Mark III torpedo. Of course, with a longer flask, as would be used in a torpedo 21 ft. long, the work done can be still further increased."

VI.

On July 26, 1910, Commander A. L. Norton, the Bureau of Ordnance officer in charge of torpedo work, visited the plaintiff company to confer with the said Gregory C. Davison on the subject of air compressors and gyroscopic control gear, and at that time learned from said Davison somewhat of the progress of certain experimental work by him in developing torpedo motive power by the injection of water into the combustion chamber, but was not shown any of the compo-

nent parts of the apparatus used. Commander Norton at that time requested Davison to take up again the matter of the development of his steam generator, along with other matters of interest to the Bureau of Ordnance.

VII.

Under date of August 8, 1910, plaintiff company wrote the Chief of the Bureau of Ordnance as follows:

"Sir: Referring to the device which we have developed for increasing the range of automobile torpedoes, we beg to submit herewith a proposition whereby the bureau may acquire the rights to said apparatus:

"1. At the present writing no steps have been taken to exploit this apparatus abroad and no information has been given out concerning it. If the United States Government desires to secure exclusive rights to the exclusion of all foreign governments we are prepared to enter into such an arrangement, the terms for which would be submitted upon request. Owing to the fact that the volume of foreign torpedo business is very greatly in excess of the United State business, the price for this exclusive right would have to be very much higher than the price for the United States rights. The price for such exclusive rights would have to be agreed upon in advance subject to the satisfactory demonstration of the apparatus, and the offer would be limited to a period of 30 days after the completion of a successful demonstration.

"2. Assuming that the United States rights only are to be acquired by the Government, we would propose that the acquirement of the rights and payment therefor be made contingent upon the successful demonstration of the guaranteed qualities of the torpedoes fitted with this apparatus. If this demonstration is made upon a converted torpedo, the same is to be loaned to us by the Navy Department, the conversion and tests to be carried out at our own
21 expense, and in the event of a failure to demonstrate the guarantees the torpedo is to be restored to its original condition and returned to the Government without cost. In the event of a successful demonstration the Government will take over the converted torpedo at a price to be agreed upon in advance. The department's option to take over the rights upon terms to be agreed upon in advance of the experiment or loan of torpedo will be limited to a period of three (3) months after the successful demonstration.

"The terms which we are prepared to offer the department now are as follows:

"Cash payment of $100,000.00 on closing the option, with the provision that the department shall pay the following royalties on each torpedo in which the apparatus is used in the future, viz:

"For the first 100 torpedoes, $1,200.00 per torpedo.

"For the second 100 torpedoes, $950.00 per torpedo.

"For the third 100 torpedoes, $750.00 per torpedo.

"For all subsequent torpedoes, $600.00 per torpedo.

"In return for this cash payment and the above royalties we would

grant to the department the right to manufacture the apparatus itself, as well as the right to fit it in torpedoes of any make. The license, however, would not include the right to grant sublicenses to other companies unless the Electric Boat Company should be unable or refuse to accept any orders offered by the department for the manufacture of the appliance or fitting it in torpedoes. Such orders shall allow a reasonable time for the work, and shall be on a basis of reasonable manufacturer's profits plus the agreed royalty. The option and the license to contain a clause specifying that all information, plans, data are to be treated as confidential, and that the department is to take reasonable precautions to enforce this feature, it being expressly understood that no plans or other information shall be shown or given to any corporation, firm, or person engaged or interested in the manufacture or development of torpedoes or torpedo appliances.

"The option is to contain a clause making the license agreement obligatory upon the department in case of a successful demonstration of the guarantees.

"All plans and detailed information with respect to the apparatus together with the converted torpedo are to be furnished to the department at the time the license agreement goes into effect, and the department is to be entitled to all improvements made during the life of the license.

"It is proposed to make the license run fifteen (15) years.

"The license to contain a provision that if in any one year the royalty fails to amount to the sum of $25,000, including the apparatus manufactured by the department and by the Electric Boat Company for the department, it shall be optional with the Electric Boat Company to cancel the license."

VIII.

On September 6, 1910, the Bureau of Ordnance, with a view to determining the merits of the different motive power systems for increasing the range and speed of torpedoes, addressed sub-
22 stantially similar letters to the Bliss Company and the plaintiff company, proposing to each company that it undertake on an experimental basis the construction of an 18-inch torpedo on a fixed price basis for a specified minimum performance of a 4,000-yard run at a speed of 26 knots, with a bonus for excess performance, each company being informed that the torpedo constructed by it would be placed in competition with a torpedo to be submitted by another firm and with torpedoes being developed by the bureau itself. Following correspondence between the bureau and each of said companies relative to price, terms, and conditions, similar contracts were entered into between the bureau and said companies for the production by each company of both an 18-inch and a 21-inch torpedo, the contracts with the plaintiff company being dated January 17 and 23, 1911; and those with the Bliss Company being dated February 16, 1911.

The Bliss Company completed its 21-inch torpedo in August, 1911; and it was tested in the fall of that year and accepted and paid for by the Government on the basis of having attained a range of 10,000 yards at a speed of 26 knots. The 18-inch torpedo was completed by said company about May, 1912; its performance in the tests was far in excess of the minimum requirements of the contract, and it was accepted and paid for at the contract price.

On January 18, 1912, the Bureau of Ordnance was preparing a contract with the Bliss Company for the manufacture of 50 torpedoes having power plants like that of the 21-inch Bliss torpedo above referred to, and in the month of June, 1912, the Government let contracts to the Bliss Company for the manufacture of 290 torpedoes having similar power plants.

The plaintiff company completed its 18-inch torpedo about October, 1912; but it failed in the tests to meet the minimum requirement of the contract for a range of 4,000 yards, and was therefore not accepted by the Government. The 21-inch torpedo was never completed by the plaintiff company; and, finally, on June 16, 1914, the contracts for said torpedoes were, at said company's request, canceled by the Government without penalty.

IX.

On October 20, 1911, the Electric Boat Company wrote the Bureau of Ordnance a letter reading as follows:

"1. We beg to inform the bureau that we have developed a device which may be applied to any automobile torpedo now in service and which will more than double the range of such torpedo.

"2. We inclose herewith drawing No. C-10227, showing a general arrangement of this device applied to the Whitehead 5.2 m. x 45 cm. torpedo.

"3. In order to apply this system to existing torpedoes, it becomes necessary to increase the length of the torpedo about eight inches.

"4. If applied to the B. L. 5 m. x 45 cm., Mark III torpedo the length would not be increased to more than 5.2 meters.

"5. We have made a number of actual tests with this device and have obtained 150,000 foot-pounds of energy per pound of air. This compares with about 40,000 foot-pounds per pound of air in
23 the B. L. 5 m. x 45 cm., Mark III, and 60,000 foot-pounds per pound of air in the Whitehead 5.2 m. x 45 cm. torpedo.

"6. If the bureau desires us to fit one of its existing torpedoes with this device, we shall undertake to do so after arranging with the bureau for a royalty to be paid on all torpedoes fitted with this device in the future.

"7. Our estimate of time required to modify an existing torpedo is five months, and cost, fifteen hundred dollars ($1,500.00).

"8. We would ask one thousand dollars ($1,000) royalty per torpedo for the first ten torpedoes, nine hundred dollars ($900)) per torpedo for the second ten, and eight hundred dollars ($800) per torpedo for all torpedoes thereafter."

At this time the Government possessed a large number of Whitehead torpedoes of 4,000 yards, and under, range.

Said letter and drawing were transmitted by the bureau to Commander Williams, inspector of ordnance in charge of the torpedo station at Newport, who, under date of October 27, 1911, returned it to the bureau with an indorsement as follows:

"Subject: Holland Torpedo Boat Co.: Rel. device which may be applied to automobile torpedo to double the range.

"1. The blue print forwarded herewith gives no information as to the methods by which the range of the torpedo is to be doubled beyond stating that the device is a steam generator. It is presumable that the device consists of a superheater into which is injected water. The E. W. Bliss Company, proceeding along the same lines, have already a torpedo in the water which indicates the possibility of doubling the range of the torpedoes now in the service. The torpedo station will in a very short time take up actual tank experiments with a new form of superheater which promises to double the range of the torpedo. The Schneider Company and the Whitehead Company are both experimenting with a superheater into which water is injected.

"2. In view of the above it is not considered wise to enter into an agreement with the Electric Boat Company by which the bureau agrees to pay the Electric Boat Company a royalty for the use of a device in torpedoes presumably similar to devices made by other companies, and to one which is in the course of development at the torpedo station, as by that action the bureau would, in the opinion of the torpedo station, possibly involve itself in dispute if not in litigation with the other companies, and would be estopped from further development of its own superheater.

"3. A preferable procedure, the torpedo station believes, would be to place an order with the Electric Boat Company for a number of torpedoes, paying them the same price that the bureau pays the E. W. Bliss Company for torpedoes of equal capabilities, buying the torpedoes simply as commercial articles, and having no question of royalty or patent rights enter into the contract.

"4. As pertinent to this question it is suggested to the bureau that its files will probably be found to contain a description of a superheater into which water is injected, this description being given to the bureau in 1907 or 1908 by a foreign naval attaché."

24 The bureau, on November 2, 1911, returned the letter to Commander Williams with the following endorsement:

"Subject: Holland Torpedo Boat Co.: Rel. device which may be applied to automobile torpedoes to double range.

"1. Returned for further comment.

"2. The proposition submitted by the Electric Boat Company in the attached letter, as understood by the bureau, is in effect as follows:

"That they will take one of the present type of torpedoes, a Mark V Whitehead, or a Mark III, IV, or VI Bliss-Leavitt torpedo, and by the installation of the Davison steam generator and the removal of superheater, practically double the range of the torpedo, provided the torpedo will stand a lengthening of eight inches.

"3. As the inspector of ordnance is no doubt aware, the bureau has contracts with the Electric Boat Company to furnish 2 5.2 m. x 45 cm. and a 21′ x 21″ torpedo of the Davison type, which torpedoes will be run some time this fall or early next spring.

"4. The attached correspondence is in reference to an entirely different proposition and yet connected with that proposition, inasmuch as the steam generating device will be incorporated in the Davidson torpedoes, and the bureau is given to understand that this generator is not in any sense a superheater, that it has been patented, and it is not to conflict with the present superheater rights.

"5. Comment is desired on the advisability of loaning the Electric Boat Company a torpedo of the Mark IV or Mark VI types in order that their device may be installed therein for test, since if it is possible to increase the range of the present four-thousand-yard torpedoes to eight thousand yards, a long-range torpedo could be obtained without much change in the installations for launching them overboard.

"6. Please return."

Commander Williams, in turn, on November 4, 1911, returned the letter to the bureau with the following additional endorsement:

"Subject: Holland Torpedo Boat Company: Rel. device which may be applied to automobile torpedoes to double range.

"1. Returned.

"2. The torpedo station is still of the opinion that it would be unwise to enter into any royalty agreement with the Electric Boat Company in regard to the steam generator device of a torpedo until the details of this device are thoroughly well known and it is clearly established that the device is different from other patented devices of the same nature, and the torpedo stations previous comments were merely to recommend the nonacceptance of the Electric Boat Company's proposition as submitted, without detailed description.

"3. The torpedo station can see no objection to loaning the Electric Boat Company a torpedo of the Mark IV or Mark VI type in order that this device may be installed therein for test, and recommends that a Mark VI torpedo be so loaned to be fitted and after being fitted that the torpedo be returned to the torpedo station to be tested there under the supervision of a representative of the Electric Boat Company."

As early as September 24, 1911, the Government had, on the testing range at Sag Harbor, the Bliss 21-inch torpedo, referred to in finding VIII, which had made a run of over 9,500 yards.

25 X.

On November 9, 1911, Admiral Twining, Chief of the Bureau of Ordinance, wrote the Electric Boat Company as follows:

"1. The bureau acknowledges the receipt of your letter of October 20, 1911, signed by your Mr. G. C. Davison, forwarding drawings C-10227, general arrangement of device for increasing range of Whitehead 5.2 m. x 45 cm. torpedoes.

"2. The bureau thanks you for having submitted this proposition to it for its consideration.

"3. The Bureau of Ordnance will be pleased to furnish you two 5.2 m. x 45 cm. Mark V Whitehead torpedoes, and to make a contract for installing therein your device at a total cost of $1,500 each. These torpedoes to be ready for demonstration at the naval torpedo station under the supervision of a representative of the Electric Boat Company.

"4. Referring to the matter of royalties, the bureau will have drawn up an agreement by which it will agree to pay a royalty of $1,000 per torpedo for the first ten (10) converted, nine hundred dollars ($900) per torpedo for the second ten (10) converted, and eight hundred dollars ($800) per torpedo for all torpedoes converted thereafter, with the distinct understanding, however, that no royalty is to be paid for the converting of the two torpedoes referred to above, the total cost of $1,500 each covering royalties and the cost of conversion, together with any other cost that may be incurred during the demonstration.

"5. In addition, the bureau will require that the two converted Whitehead torpedoes, referred to above, in which you have installed your device, shall make an increased range of at least fifty per cent of their present ranges (a total of 6,000 yards) on their demonstration at the naval torpedo station, it being understood that the Electric Boat Company believes it is capable of increasing the range to one hundred per cent of the present range (a total of 8,000 yards). This requirement of the bureau of fifty per cent increased range is the minimum that the bureau will consider as the increase for completion of contract for the conversion of the two torpedoes submitted for test and demonstration."

"6. If this arrangement be agreeable to the Electric Boat Company, please so inform the bureau, in order that a requisition may be prepared for the converting of two 5.2 m. x 45 cm. Whitehead Mark V torpedoes at a total cost of three thousand dollars ($3,000), and that an agreement may be drawn up for signature by the Navy Department and the Electric Boat Company in regard to the royalty to be paid for any torpedoes that may be converted hereafter, namely, at the rate of $1,000 per torpedo for the first ten torpedoes converted, $900 per torpedo for the second ten torpedoes converted, and $800 per torpedo for all torpedoes converted thereafter.

"7. An early reply will be appreciated."

On December 6, 1911, the Electric Boat Company replied to this letter as follows:

"Referring to the bureau's letter No. 656/79-80-81 (23712/2) of November 9, 1911, relative to the conversion of two White-
26 head 5.2 m. x 45 cm. torpedoes by the introduction of our device for increasing the range:

"1. The terms mentioned in the bureau's letter will be satisfactory to us.

"2. We are ready to begin work on the two torpedoes as soon as they are received.

"3. As regards paragraph 6 of the bureau's letter, it is our understanding that the royalty will apply not only to torpedoes which may hereafter be converted but also to torpedoes which the Government may build at its own works and in which the device in question is to be used."

On December 13, 1911, the Bureau of Ordnance wrote the Electric Boat Company as follows:

"Referring to your letter of December 6, 1911, relative to the conversion of two (2) Whitehead 5.2 m. x 45 cm. torpedoes by the introduction of your device for increasing the range:

"1. You are informed that the bureau has this day made out a requisition for the conversion of two (2) 5.2 m. x 45 cm. Whitehead torpedoes by the Electric Boat Company at a total cost of fifteen hundred dollars ($1,500) each, including the necessary demonstration runs at the naval torpedo station.

"2. In connection therewith the bureau is forwarding a blank shop license, or agreement, and requests that you will fill in the name of your steam-generating device and the number of the letters patent in the appropriate blanks, in order that a complete agreement may be made up and forwarded for your signature."

On December 16, 1911, the Electric Boat Company wrote the Chief of the Bureau of Ordnance as follows:

Subject: Increasing range of torpedoes.

"SIR: We beg to acknowledge receipt of your No. 23712/2 (G) of the 13th instant, forwarding draft of shop license agreement relative to our device for increasing the range of automobile torpedoes. The following is a list of the United States patents and applications whereby this device is protected:

"Application Serial No. 422,175, dated Mar. 9, 1908.

"Application Serial No. 486,455, dated Mar. 29, 1909.

"Application Serial No. 590,627, dated Nov. 10, 1910.

"U. S. Patent No. 980,243, dated Jan. 3, 1911.

"You will note that three of these applications have not yet been issued. A number of claims, however, have already been allowed under each of these applications, and delay in issuing the patents is due to argument now pending in relation to certain claims which have been rejected. The protection afforded, however, is the same as if the patents have been issued.

"We return herewith copy of draft of shop license."

On January 8, 1912, the Chief of Bureau of Ordnance replied as follows:

"1. The bureau is forwarding herewith five copies of agreement between the Electric Boat Company and the United States for the use by the United States of the device known as "Steam Generator for Automobile Torpedoes."

"2. Please have this agreement executed on the part of the Electric Boat Company by the proper responsible officials, and re-
27 turn the same to the bureau at your earliest convenience, in

order that it may be executed by the proper officials of the Navy Department.

"3. When so executed, a copy will be returned to the Electric Boat Company."

On January 12, 1912, the Electric Boat Company, in response, wrote the Bureau of Ordnance as follows:

"We inclose to you herewith five (5) copies of agreement between the Electric Boat Company and the United States for use of our device known as steam generator for automobile torpedoes which have been duly executed by this company.

"Will you kindly have these agreements executed on behalf of the United States Government, and return to us copy for our files at your convenience, and oblige."

The said agreement was executed by the plaintiff company and the Acting Secretary of the Navy under date of April 2, 1912, and was as follows:

Shop License.

"This agreement, made this 2d day of April, 1912, by and between the Electric Boat Company, a corporation organized under the laws of the State of New Jersey, party of the first part, and the United States, party of the second part, witnesseth:

"That, whereas the said party of the first part is the owner of the invention known as Steam Generator for Automobile Torpedoes covered by application Serial No. 422,175, dated March 9, 1908; application Serial No. 486,455, dated March 29, 1909; application Serial No. 590,627, dated November 10, 1910; U. S. Patent Serial No. 980,243, dated January 3, 1911.

"And whereas the said party of the second part is desirous of securing certain manufacturing rights with respect to said invention:

"Now, therefore, the said parties hereto have agreed and do hereby agree as follows:

"1. The said party of the first part hereby licenses and empowers the said party of the second part to manufacture for and on behalf of the said party of the second part either in its own shops or by contract in private shops and to use torpedoes equipped with Steam Generator for Automobile Torpedoes covered by application Serial No. 422,175, dated March 9, 1908; application Serial No. 486,455, dated March 29, 1909; application Serial No. 590,627, dated November 10, 1910; U. S. Patent Serial No. 980,243, dated January 3, 1911, and any improvements thereon now or hereafter owned or controlled by the party of the first part, subject to the conditions hereinafter named, to the end of the term for which letters patent for said invention and any improvement thereon have been or may be granted.

"2. The said party of the second part hereby agrees to pay to the said party of the first part in consideration of the license hereby granted a royalty of one thousand dollars ($1,000) for each of the first ten torpedoes equipped with the Steam Generator for Automobile Torpedoes covered by the application for letters patent and letters patent before mentioned manufactured by the party of the second

part under this license; nine hundred dollars ($900) for each of the second ten torpedoes so equipped manufactured under this license by the said party of the second part; and eight hundred
28 dollars ($800) for each additional torpedo so equipped manu-
factured under this license by the said party of the second part; no royalty to be paid or payable by the said party of the second part to the said party of the first part under this agreement until each such Steam Generator for Automobile Torpedoes shall have been tested and accepted by the said party of the second part.

"3. The said party of the first part will at its own expense defend the said party of the second part and hold it harmless against all and every demand or demands of any nature or kind heretofore made or that shall hereafter be made for or on account of the manufacture for its own use by the said party of the second part in its own shops or by contract in private shops or by reason of the adoption or use by said party of the second part of the device covered by the application for letters patent and letters patent hereinbefore mentioned—to wit, the Steam Generator for Automobile Torpedoes, or any improvements thereon now or hereafter owned or controlled by said party of the first part.

"4. The said party of the second part hereby agrees to make full and true returns to the said party of the first part, on the first day of January each year, of the number of Steam Generators and Automobile Torpedoes therewith manufacted under this license during the preceding year.

"5. No Member of or Delegate to Congress, officer of the Navy, nor any person holding any office or appointment under the Navy Department is or shall be admitted to any share or part of this contract or to any benefit to arise therefrom.

"6. Nothing in this license agreement shall be held or construed to interfere with or limit in any wise any present or future right of the party of the first part to manufacture or use the said Steam Generator for Automobile Torpedoes or any improvement or modification thereof and torpedoes equipped therewith for demonstration or other purposes whatsoever or to sell and dispose thereof.

"In witness whereof, the said parties hereto have hereunto set their hands and seals the day and year first above written."

The patent and applications for patent referred to in said agreement were all upon inventions of the said Gregory C. Davidson, by whom they had been assigned to the plaintiff.

Said patent and patent applications were not seen by the Bureau of Ordnance prior to the execution of said agreement of April 2, 1912.

XI.

Pursuant to the plaintiff's proposition of October 20, 1911, shown by Finding IX, for the equipment of an existing Government torpedo with the plaintiff company's said device plaintiff proceeded under contract with the Bureau of Ordnance to so equip two White-

head Government torpedoes, and in November, 1912, sent them to the Government torpedo station at Newport for their tests to determine whether they complied with the contract terms, the minimum range requirement of which was 6,000 yards, a 50 per cent increase of their original range. After a long period of experiments at the torpedo station, one of these torpedoes exceeded on one
29 occasion the minimum run of 6,000 yards required for
acceptance; and on October 6, 1913, the company's bill for $3,000 for the conversion of said torpedoes was approved by the Bureau of Ordnance and was thereafter paid.

On September 27, 1913, the naval torpedo board reported on these torpedoes as follows:

"In reference to paragraph 1(*f*) of the precept, the board is of the opinion that—notwithstanding the fact that one Whitehead torpedo, fitted with the steam-generating device, did, on one occasion, make a run of 6,000 yards at 27 knots after a long period of experiments at the torpedo station—the reliability of this form of steam generator has not been established, and, due to the use of salt water, there are grave doubts as to the practicability of this device as at present fitted for service use. It is recommended that no steps be taken toward the conversion of service Whitehead torpedoes into steam torpedoes of this modification until further investigation by the torpedo station has removed these doubts."

The form and character of the company's said device with which these two Whitehead torpedoes were equipped are shown by the drawing and description constituting Exhibit I of the appendix to these findings of fact, which appendix is by reference made a part of these findings of fact.

XII.

On August 20, 1912, there were granted to the plaintiff company as assignee of the said Gregory C. Davison, upon said Davison's application, Serial No. 486,455, United States Letters Patent No. 1,036,080, which are set out as Exhibit II in the appendix to these findings.

The proceedings in the Patent Office upon said application prior to the granting of said letters patent are shown in the certified copy of file wrapper and contents relating thereto, which copy accompanies, and is by this reference thereto made a part of, these findings as Exhibit A.

XIII.

Since the granting of said Letters Patent No. 1,036,080 to the plaintiff on August 20, 1912, the United States has purchased from other parties than the plaintiff, and has used, automobile torpedoes equipped with mechanism for storing, producing, and transmitting motive power, constructed and operating as shown and described by the drawing and description of operation constituting Exhibit III of the appendix to these findings of fact.

The character and mode of operation of said mechanism is further shown by the blue prints of drawings and the model of reducing valve accompanying, and hereby made a part of these findings of fact as Exhibits B-1, B-2, B-3, and B-4, respectively.

Said mechanism, except for slight improvements and modifications, is a practical duplicate of that of the Bliss Company torpedo, built under the said contract of February 6, 1911, referred to in Finding VIII, and which was tested and accepted by the Government in the fall of 1911.

30 XIV.

The following patents and publication show the development and state of the art to which the plaintiff's said patent No. 1,036,080 relates:

1. United States patent to Maxim, No. 641,787, of January 23, 1900.
2. United States patent to Leavitt, No. 693,871, of February 25, 1902.
3. United States patent to Leavitt, No. 693,872, of February 25, 1902.
4. British patent to Sodeau, No. 3,495, of August 12, 1905.
5. British patent to De Ferranti, No. 9,496, of 1904, published August 17, 1905.
6. United States patent to De Ferranti, No. 925,889, of June 22, 1909; application filed April 17, 1905.
7. United States patent to Sodeau, No. 835,262, of November 6, 1906.
8. British patent to Sodeau, No. 15,997, of 1906; published July 17, 1907.
9. United States patent to Sodeau, No. 944,975, of December 28, 1909; application filed March 25, 1907.
10. British patent to Sodeau, No. 6,081, of 1907; published April 23, 1908.
11. United States patent to Sodeau, No. 964,574, of July 19, 1910; application filed January 27, 1908.
12. British patent to Gesztesy, No. 18,241, of 1908; published March 3, 1909.
13. French patent to Gesztesy, No. 393,324; published December 19, 1908.
14. Revista Maritima Braziliera, published January, 1908.
15. United States patent to Davison, No. 1,036,082, of August 20, 1912; application filed March 19, 1908.

Copies of said patents and publication accompany, and are by this reference thereto made a part of, these findings of fact as Exhibits C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8, C-9, C-10, C-11, C-12, C-13, C-14, and C-15, respectively.

XV.

The devices of the plaintiff's said Letters Patent No. 1,036,080 which are claimed by the plaintiff to have been manufactured or

used by the United States, and for the manufacture or use of which the plaintiff seeks a recovery in this cause, are the devices of claims 1, 5, and 13 of said letters patent.

It does not appear from the evidence that any of said devices or inventions have been manufactured or used by the United States.

Conclusion of Law.

Upon the foregoing findings of fact, the court decides, as a conclusion of law, that the plaintiff is not entitled to recover, and its petition is therefore dismissed.

31 Judgment is rendered against the plaintiff in favor of the United States for the cost of printing the record in this cause, the amount thereof to be entered by the clerk and collected by him according to law.

Opinion.

Per Curiam: The defendant's motion for a new trial was allowed and additional evidence has been adduced. The findings of fact have been amended in important particulars.

The action is upon an alleged express contract. The facts show the circumstances under which this contract was made, and, at most, it can be said to be a shop license covering the use of the particular device in torpedoes covered by Davison's patents or applications. Other patents in use and the state of the art convince us that other patentees than Davison, and the Government as well, were experimenting with torpedoes having steam generators at and before the time of the shop license contract. Not only were experiments being made but the Sodeau and other patents in evidence disclose a steam generator. The question resolves itself into whether the Government used the plaintiff's device or something covered by one of the claims in its patents. We are of the opinion it did not. And if there be any doubt on this issue the court is of opinion that the shop license should not be so liberally construed as to prevent the Government showing the exact nature of the device it used and its difference from that covered by the plaintiff's claims.

The petition will be dismissed, and it is so ordered.

32 **APPENDIX.**

Exhibit I.

"Operation of Steam Generating Plant.

"When the starting lever and water tripper are thrown back, the air passes in the usual manner from the air flask through the stop and starting valves to the main reducing valve fig. 1. This valve does not open at first, being held closed by a light spring, and the high-pressure air continues through the pipe *a* to a small auxiliary

reducing valve fig. 2, which is generally set by spring b for a constant starting pressure of 150 pounds. This starting air passes by way of pipe c through the generator fig. 3 to the engine fig. 4, starting the same. The water pump fig. 5 being directly driven by the engine crank shaft through an extension shaft at d then draws the water from the sea through the priming tube e and discharges into the combined water regulator and pump air chamber fig. 6. From there the water passes through the port f in the check valve support fig. 7 by way of pipe g to the equalizing valve fig. 8 and from there through pipe h to the top side of the flexible diaphragm i in the main reducing valve fig. 1.

"The equalizing valve being held open by a light spring j on top of the flexible diaphragm k and by the starting air pressure through pipe l also allows the water to pass into check valve support fig. 7 by way of pipe m and from there through check valves n and o to fuel tank fig. 9 through lead p and to the generator fig. 3 through lead q. A small pipe r also carries the water to the tripping mechanism of the igniter s. In this pipe the delay pot t is placed.

"The fuel by the pressure of the water is forced out through pipe u and check valve v to the burner x where it is atomized by the starting air. At that moment the water acting on a diaphragm in the igniter s trips the firing pin and fires the cartridges, igniting the mixture in the generator pot. Meanwhile the water which entered
33 the generator through pipe q has filled the water jacket y and returned through the return pipe z to the bottom fitting a^1. From there it passes through a number of small holes b^1 in the neck of the lining c^1 into the flame and is instantly converted into steam, which is carried to the engine by way of pipe d^1. As soon as the steam replaces the cold starting air, the engine speeds up, the pump furnishes additional water pressure, which throws the main reducing valve open and the whole system works at its set pressure. This pressure is varied to any desired amount by means of water-regulator spring e^1, and the excess water passes out through overflow valve f^1 to the sea.

"The office of the equalizing valve is to correct any effect on air, water, and fuel due to any error in the main reducing valve.

"The check valves prevent back firing, when the ignition takes place, and also stop fuel from filling generator pot before ignition. These valves should be examined whenever the torpedo is broken down for overhauling of the engine and be kept free from foreign matter, that may prevent their function.

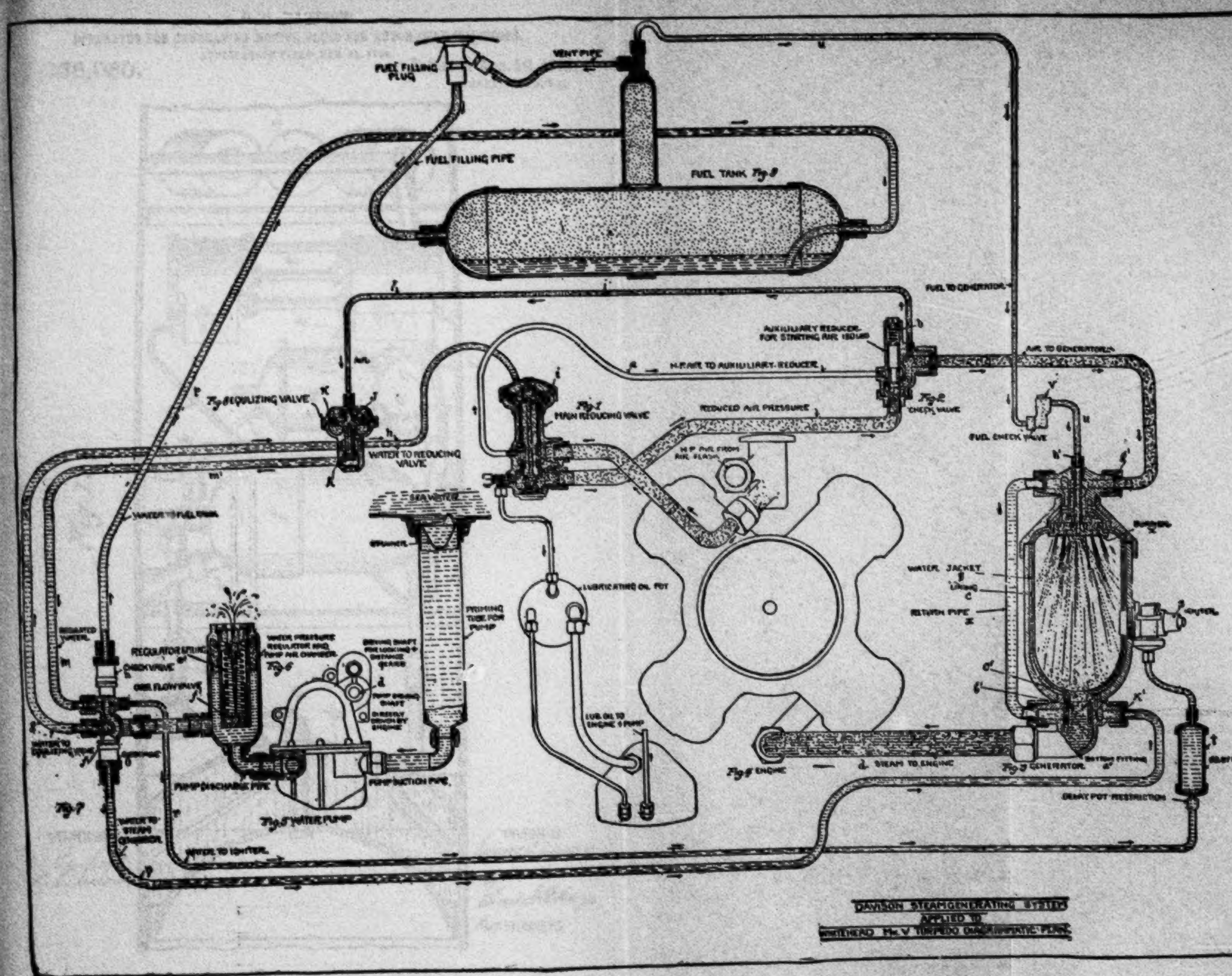
"When preparing the torpedo for a run the fuel tank is filled through filling plug l^1. Pipe m^1 serves as a vent. Two cartridges are screwed into this igniter s and the regular spring e^1 is set for the desired pressure.

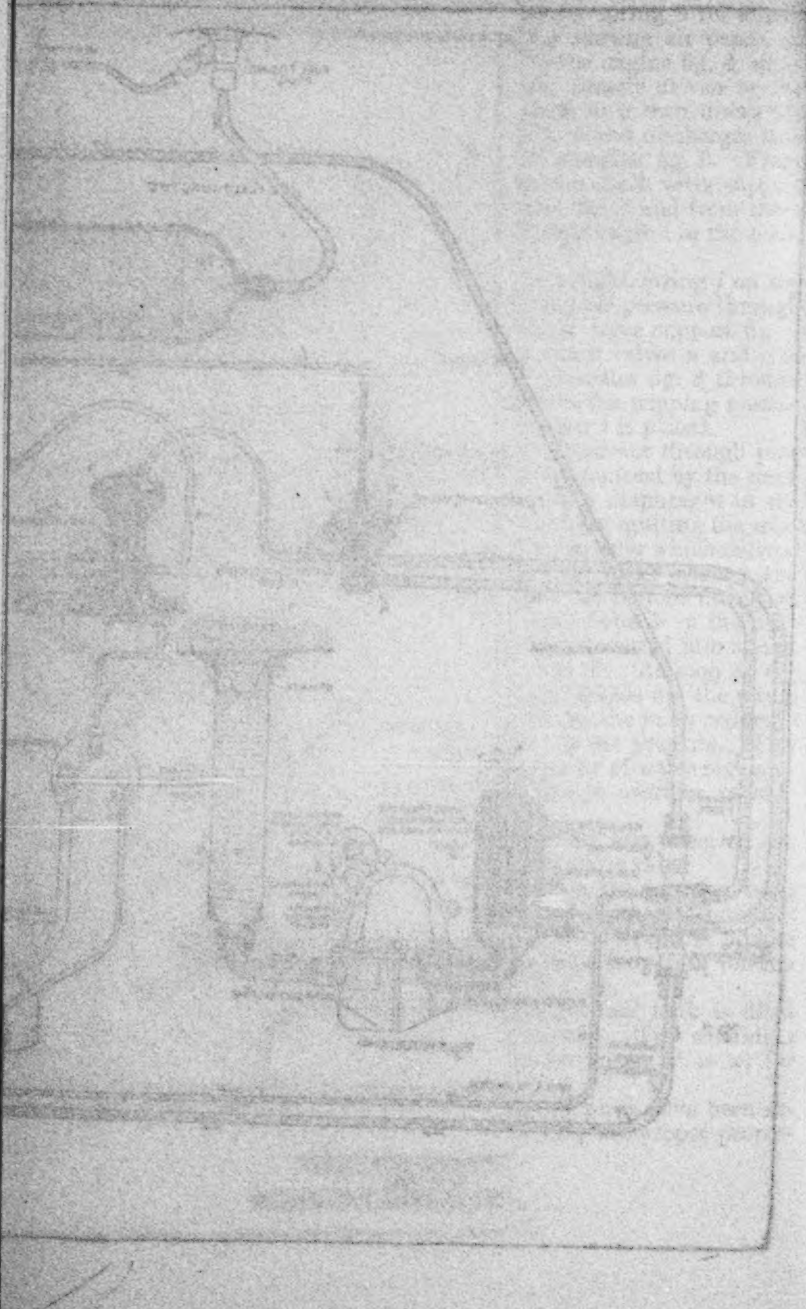
"A set of restrictions for air, water, and fuel pipes have been arrived at experimentally. These restrictions keep the proper proportions of air, fuel, and water and are:

"For air, 0.″375 diameter—located at g^1.

"For fuel, 0.″041 diameter—located at h^1.

"For water, 0.″09 diameter—located at k^1.


FUEL FILLING PLUG
VENT PIPE
FUEL FILLING PIPE
FUEL TANK Fig. 8
FUEL TO GENERATOR
AUXILIARY REDUCER FOR STARTING AIR
AIR TO GENERATOR
H.P. AIR TO AUXILIARY REDUCER
Fig. 2 CHECK VALVE
REDUCED AIR PRESSURE
Fig. 1 MAIN REDUCING VALVE
Fig. EQUALIZING VALVE
WATER TO REDUCING VALVE
FUEL CHECK VALVE
WATER TO FUEL TANK
SEA WATER
STRAINER
PRIMING TUBE FOR PUMP
LUBRICATING OIL POT
WATER JACKET
RETURN PIPE
IGNITER
REGULATOR SPRING
CHECK VALVE
OVER FLOW VALVE
WATER PRESSURE REGULATOR AND PUMP AIR CHAMBER Fig. 6
PUMP DISCHARGE PIPE
PUMP SUCTION PIPE
Fig. 5 WATER PUMP
LUB. OIL TO ENGINE & PUMP
Fig. 4 ENGINE
STEAM TO ENGINE
Fig. 3 GENERATOR
DELAY POT RESTRICTION
Fig. 7
WATER TO STEAM GENERATOR
WATER TO IGNITER
DAVISON STEAMGENERATING SYSTEM
APPLIED TO
WHITEHEAD Mk V TORPEDO DIAGRAMMATIC PLAN



G. C. DAVISON.

APPARATUS FOR GENERATING MOTIVE FLUID FOR AUTOMOBILE TORPEDOES.

APPLICATION FILED MAR. 29, 1909.

1,036,080. Patented Aug. 20, 1912.

2 SHEETS—SHEET 1.

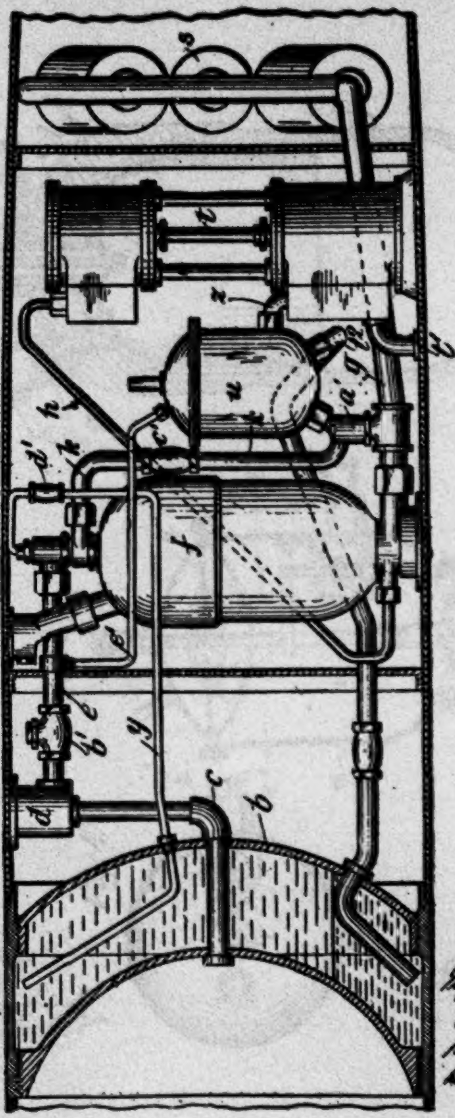


Fig. 1.

WITNESSES:
L. B. Penfield
L. A. Barlow.

INVENTOR
Gregory C. Davison
by
[signature]
his ATTORNEYS

G. C. DAVISON.

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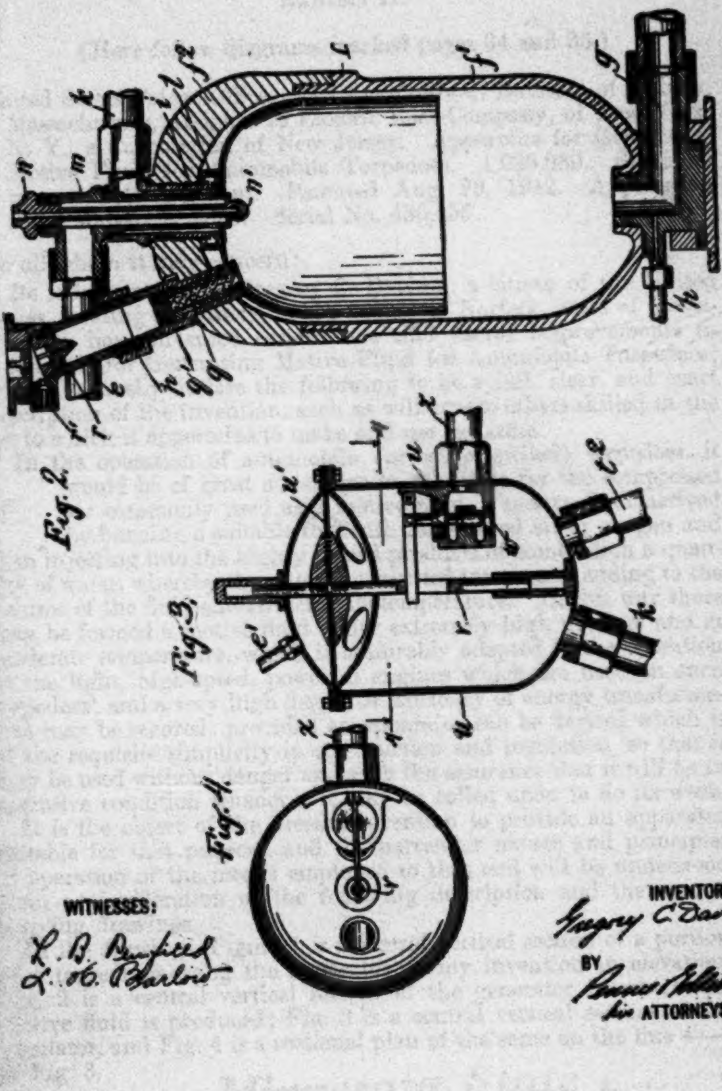
3 SHEETS—SHEET 2.



WITNESSES:

INVENTOR

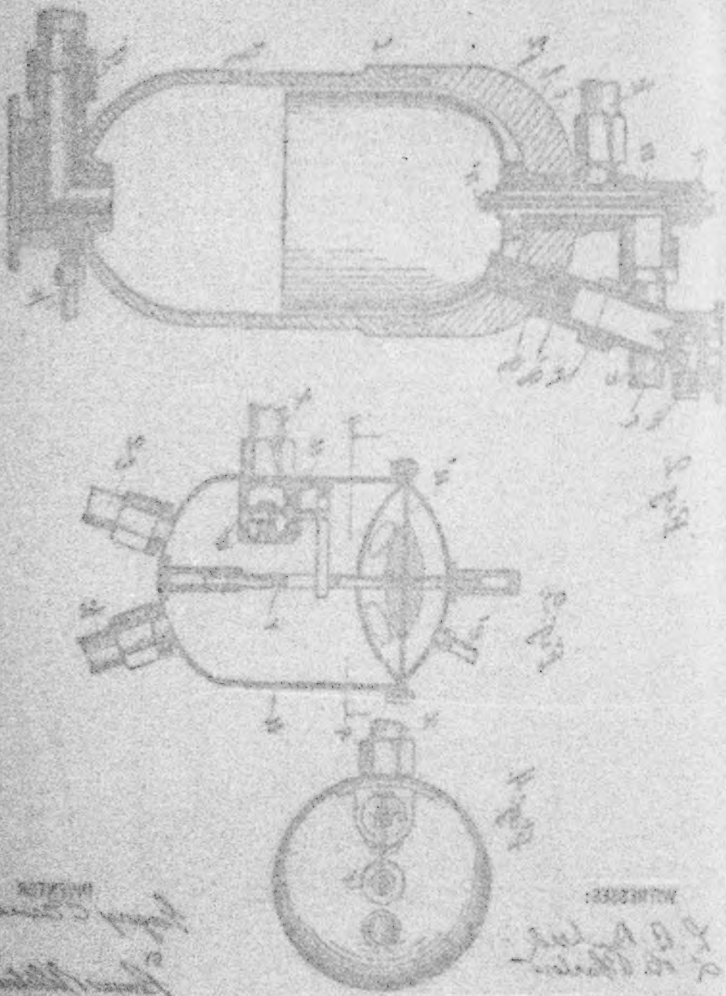
Gregory C. Davison

BY

his ATTORNEYS

G. C. DAVISON.
APPARATUS FOR GENERATING MOTIVE FLUID FOR AUTOMOBILE TORPEDOES.
APPLICATION FILED [illegible]

1,088,080. Patented [illegible]



WITNESSES:

INVENTOR

ATTORNEYS

"For 50 horsepower or about 28.5 knots speed.
"The working pressures are:
"For water, 340 pounds.
"For air, 325 pounds.
"For steam, 300 pounds."

Exhibit II.

(Here follow diagrams marked pages 34 and 35.)

United States Patent Office. Gregory Caldwell Davison, of Quincy, Massachusetts, Assignor to Electric Boat Company, of New York, N. Y., a Corporation of New Jersey. Apparatus for Generating Motive Fluid for Automobile Torpedoes. 1,036,080. Specification of Letters Patent. Patented Aug. 20, 1912. Application Filed March 29, 1909. Serial No. 486,455.

To all whom it may concern:

Be it known that I, Gregory C. Davison, a citizen of the United States, residing at Quincy, in the county of Norfolk, State of Massachusetts, have invented certain new and useful Improvements in Apparatus for Generating Motive Fluid for Automobile Torpedoes; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

In the operation of automobile (or self-propelled) torpedoes, it would be of great advantage to substitute for the compressed
36 air commonly used as a motive fluid, a motive fluid derived
by burning a suitable fuel with compressed air or oxygen and then injecting into the highly heated products of combustion a quantity of water, whereby the water is converted into steam, adding to the volume of the fluid and reducing its temperature. In this way there may be formed a motive fluid under extremely high pressure and at moderate temperature, which is admirably adapted to the operation of the light, high-speed, powerful engines which are used on such torpedoes; and a very high degree of efficiency of energy transformation may be secured; provided an apparatus can be devised which is of the requisite simplicity in construction and regulation, so that it may be used without danger and with the assurance that it will be in operative condition whenever it may be called upon to do its work.

It is the object of the present invention to provide an apparatus suitable for that purpose, and the particular nature and principles of operation of the means employed to that end will be understood from a consideration of the following description and the accompanying drawings.

In the drawings, Figure 1 is a central vertical section of a portion of a torpedo showing the apparatus of my invention in elevation. Fig. 2 is a central vertical section of the generator in which the motive fluid is produced; Fig. 3 is a central vertical section of the regulator, and Fig. 4 is a sectional plan of the same on the line 4—4 of Fig. 3.

The oxygen-carrier, preferably air or oxygen, under pressure, is contained in a tank *a*, which, in the construction illustrated, is formed by partitioning off a portion of the body of the torpedo in the customary way; and the fuel is contained in a tank *b*, which is likewise formed by partitioning off a portion of the body of the torpedo. A take-off pipe *c* leads from the tank *a* to and through reducing valve *d*, which is of the type commonly used in torpedoes of this class and is adapted to be opened automatically when the torpedo is launched. From here the oxygen-carrier flows at a reduced pressure through the pipe *e* to the generator *f*, within which it is intended that the mixed fuel and oxygen-carrier shall be burned, and charged with water vapor. The construction of the generator *f* will be understood from Fig. 2, from which it will be seen that the generator comprises a strong cylindrical tank with rounded ends made in two parts f' and f^2. The lower portion f' has tapped into it at the bottom the take-off pipe *g* leading to the engine, and the take-off pipe *h* of considerably smaller capacity leading to the pump. The upper part f^2 of the generator has tapped into it centrally at the top the compound nozzle. This nozzle comprises an outer threaded sleeve *i*, into which the water pipe *k* leads, and which terminates within the cylinder in a spraying-head *l*, having spray-holes adapted to discharge the water tangentially against the upper end of the cylinder to set up a circumferential or whirling motion; an intermediate sleeve *m* with which is connected the pipe *e* containing the oxygen-carrier; and a central nozzle *n* for the fuel, said nozzle *n* terminating in a rounded head n' having spray-holes as shown. Secured to the water spray-head *l* and separating the water spray from the fuel and oxygen-carrier is the dome-shaped hood *o* extending well down into the body of the cylinder, the object of the
37 hood being to prevent the injection of water into the mixed
fuel and oxygen-carrier before the combustion is complete. It will be understood that the water sprayed from the head *l* will flow down over the heated hood *o* and the water vapor will mix with the products of combustion in the lower portion of the generating chamber. For starting combustion within the generator I provide a device which is automatically actuated as soon as the oxygen-carrier under pressure is admitted into the generating chamber. For this purpose, I have adopted a known construction of ignition device and have so located it that it is in communication with the generating chamber at the upper portion of the hood *o* in proximity to the compound nozzle. This device comprises a receptacle *p*, in which slides a fuse carrier containing an ignition fuse *q* and carrying a percussion cap q', and capable of sliding up the bore of the receptacle *p* into contact with the firing projection *r*. This firing projection has a central passage for the escape of the air within receptacle *p* when the ignition fuse rises therein, such air passing through the central passage in firing projection *r* and through the spring-pressed check-valve r'. Upon admission of the oxygen-carrier under pressure to the generating chamber *f* through the pipe *c* and sleeve *m* the fuse-carrier is forced up the bore of receptacle *p* until percussion cap q' strikes firing projection *r* and the fuse is ignited.

A slow burning fuse is preferably used so that the combustible mixture which has formed in the generating chamber will surely be ignited. The manner in which the fuel and water are fed to the generating chamber will be further described hereafter.

From the generating chamber the products of combustion are led, on the one hand, through the pipe g to the engines s, and on the other hand, through the pipe h to the pump t. This pump is connected with the water at t', and with the regulator u at x. The construction of this regulator will be understood from Figs. 3 and 4, from which it will be seen that it comprises a casing divided into an upper and lower chamber by a flexible diaphragm u', which diaphragm carries an adjustable slotted stem v actuating the double-seated balanced valve w, which controls the inlet passage from the pipe x leading from the delivery side of the pump. Into the lower portion of the lower chamber of the regulator is also tapped the outlet pipe t^2 leading to the lower portion of the full tank b and the outlet pipe k leading to the water nozzle. Into the upper part of the regulator above the flexible diaphragm is tapped the pipe e' branching from the pipe e and containing the oxygen-carrier under pressure. From the upper part of the fuel tank b there extends to the fuel nozzle n a fuel pipe y.

With this construction and arrangement of parts the pressure of the oxygen-carrier in the pipe e on the low pressure side of the reducing valve d controls absolutely the pressure on the fuel and the pressure on the water supply to the generating chamber, so that the oxygen-carrier, the fuel and the water are fed always at a predetermined pressure to the generating chamber, and if, for any reason, the supply of oxygen-carrier is cut off or exhausted, the supply of fuel and water to the generating chamber will cease at once, while, as long as there is a supply of oxygen-carrier under pressure and the flow of water into the regulator chamber is not interrupted, the supply of fuel and water to the generating chamber will continue
38 under proper control. Furthermore, by this arrangement the fuel in the fuel tank, as it is withdrawn, is replaced by water, which, of course, remains at the bottom of the tank. This prevents a possibility of the admission of air or oxygen into the fuel tank and the formation therein of an explosive mixture. But a single pump is necessary to feed both the fuel and the water and it is made certain that the fuel and the water will be fed under the same pressure and will both be controlled by the pressure of the oxygen-carrier. This dependence of the fuel supply upon the water supply, and their mutual dependence upon the single pump and the pressure of the oxygen-carrier, is of further advantage in that it is impossible that the water supply should be stopped and the fuel supply continued, thereby creating unduly high temperatures in the generating chamber and engine. Furthermore, it will be observed, the arrangement is such, that if, for any reason, such as the breaking down of the water pump, the flow of water into the regulator chamber is interrupted, the supply of fuel will immediately cease, thus bringing the combustion to an end and preventing unduly high

temperatures; but, nevertheless, the air or oxygen under pressure will continue to flow from the storage tank through the combustion chamber to the engine, and the torpedo will continue to be driven until the supply of oxygen-carrier under pressure is exhausted.

The operation of the system as a whole is as follows: When the torpedo is launched the valve *d* is opened automatically and the oxygen-carrier at the predetermined pressure is admitted to the upper portion of the generating chamber through the pipe *m*. The pressure thus produced in the generating chamber forces the fuse-carrier up the bore of receptacle *p* against the firing projection and ignites the fuse. The fuse contains a slow burning composition preferably one which will burn for several seconds, and before it is burned out, the pump, actuated initially by the oxygen-carrier passing through pipe *h*, will force fuel through the nozzle *n* into the generator, there forming an explosive or combustible mixture which will be ignited by the fuse. At the same time, or substantially the same time, that the fuel is admitted, jets of water will be thrown with a circumferential or whirling motion from the sprayer head *l* into the space between the hood *o* and the body of the generator, and as the hood heats up and the hot products of combustion accumulate the water will be vaporized and mixed with the products of combustion, but by reason of the interposition of the hood *o* the combustion will be complete before the mixture takes place so that the water can not interfere with the combustion. The mixed products of combustion and water vapor in the lower portion of the generator pass through the pipe *g* to the engine and through the pipe *b* to the pump.

In the pipe *g* between the generating chamber and the engine, I prefer to place a safety valve *a'*, and in pipes *t*, *k* and *y* check-valves *b'*, *c'* and *d'* are interposed to prevent a back flow due to a sudden high pressure in the generator.

The above-described arrangement of parts provides an operative system for automobile torpedoes which is simple, self-starting, self-regulating and well protected against accidents.

39 What I claim is:

1. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor. a tank for an oxygen-carrier under pressure, a water supply, a fuel supply, an auxiliary source of pressure for the water and fuel supply, a conduit leading from the oxygen-carrier tank to the combustion chamber, a second conduit through which the pressure of the oxygen-carrier is applied to regulate the pressure of the fuel and water supply, valve mechanism controlling said conduits, connections through which the fuel and water may freely pass under the pressure of the oxygen-carrier into the generating chamber, and a connection from the combustion chamber to the driving engine of the torpedo, whereby the flow of water and fuel feed to the generator depends at all times upon and is regulated by the pressure of the oxygen-carrier, but the flow of the oxygen-carrier is independent of the water and fuel supply.

2. In an automobile torpedo, motive fluid generating apparatus comprising a tank for storing an oxygen-carrier under pressure, a combustion chamber having an outlet conduit leading to the driving engine, and a conduit extending from the storage tank to the combustion chamber, the said elements constituting a power system in which the stored oxygen-carrier may flow from the storage tank through the combustion chamber to the engine to operate it; in combination with means for supplying a combustible and water to the combustion chamber, and means for discontinuing the combustible supply upon failure of the water supply, without interrupting the flow of oxygen-carrier to and through the combustion chamber and thence to the engine.

3. In apparatus for generating motive fluid for automobile torpedoes, a tank for storing an oxygen-carrier under pressure, a water pump, and a source of fuel supply, a combustion chamber, a supply conduit from the oxygen-carrier tank to the combustion chamber, a driving engine, a conduit from the combustion chamber to the engine, a conduit from the water pump to the combustion chamber, a conduit from the fuel supply to the combustion chamber and a connection through which the pressure on the water supply is applied to the fuel supply; substantially as described.

4. In apparatus for generating motive fluid for automobile torpedoes, a tank for storing an oxygen-carrier under pressure, a water pump, and a source of fuel supply, a combustion chamber, a supply conduit from the oxygen-carrier tank to the combustion chamber, a driving engine, a conduit from the combustion chamber to the engine, a conduit from the water pump to the combustion chamber, a conduit from the fuel supply to the combustion chamber, a connection through which the pressure on the water supply is applied to the fuel supply, and a connection through which the pressure of the oxygen-carrier is applied to regulate the pressure of the fuel and water supply; substantially as described.

5. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, a water supply and a fuel supply, means for injecting the water and fuel into the generating chamber, a supply of oxygen-carrier under pressure, and a regulator controlled by the pressure of the oxygen-carrier and controlling the water and fuel supply.

6. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, a source of water supply under pressure for injecting water into the products of combustion, a fuel tank connected to the generating chamber, connections from the source of water supply to the fuel tank, a supply of oxygen-carrier under pressure, and a regulator controlled by the pressure of the oxygen-carrier for regulating the flow of water from the source of water supply to the generating chamber and fuel tank.

7. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, a source of water supply under pressure for injecting water into the products of combustion, a fuel tank connected to the generating chamber, connections from the source of water supply to the fuel tank, a supply of oxygen-carrier under pressure, and a regulator interposed in the connections from the source of water supply to the generating chamber and fuel tank for regulating the flow of water from the said source, said regulator comprising a casing, a flexible diaphragm dividing the casing into two chambers, with one of which chambers the inlet from the source of water supply and the outlet to the generating chamber and the fuel tank communicate, a valve connected to the diaphragm and controlling the inlet from the source of water supply, and connections for admitting the oxygen-carrier under pressure to the other chamber of the regulator casing.

8. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, inlet devices for the fuel and oxygen-carrier, a dome-shaped hood about said devices, and a water spray-head arranged to spray water on the outside of said hood.

9. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, inlet devices for the fuel and oxygen-carrier at the upper part of the generating chamber, a hood overhanging said inlet devices, and a water spray-head for directing jets of water on the outside of said hood.

10. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber having a dome-shaped upper end and in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, inlet devices for the fuel and oxygen-carrier at the upper part of the generating chamber, a hood overhanging said inlet devices and substantially conforming in shape to the dome-shaped upper end of the generating chamber and a centrally located water spray-head between the end of the chamber and the hood for directing jets of water on the outside of said hood.

11. In apparatus for generating, motive fluid for automobile torpedoes, a tank for an oxygen-carrier under pressure, a fuel
41 tank, a generating chamber, a regulator casing, a pump, and a fluid-operated motor, connections extending from the oxygen-carrier tank and from the fuel tank to the generating chamber, whereby the oxygen-carrier and fuel are admitted to the generating chamber to be burned therein, connections extending from the generating chamber to the fluid actuated motor and to the pump, whereby the products of combustion are led to the motor and pump to actuate the same, connections extending from the pump to the regulator casing and from the regulator casing to the fuel tank and to the generating chamber, a branch connection extending from the oxygen-

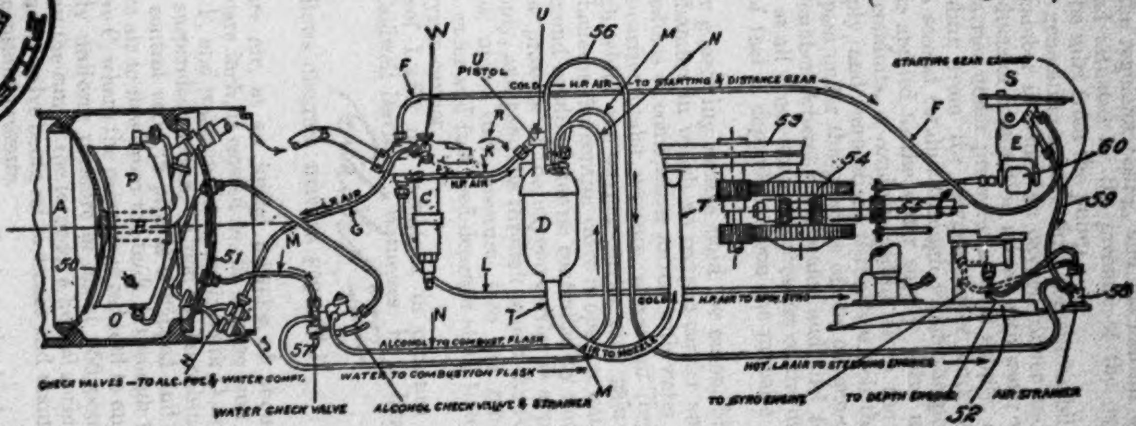
Exhibit III

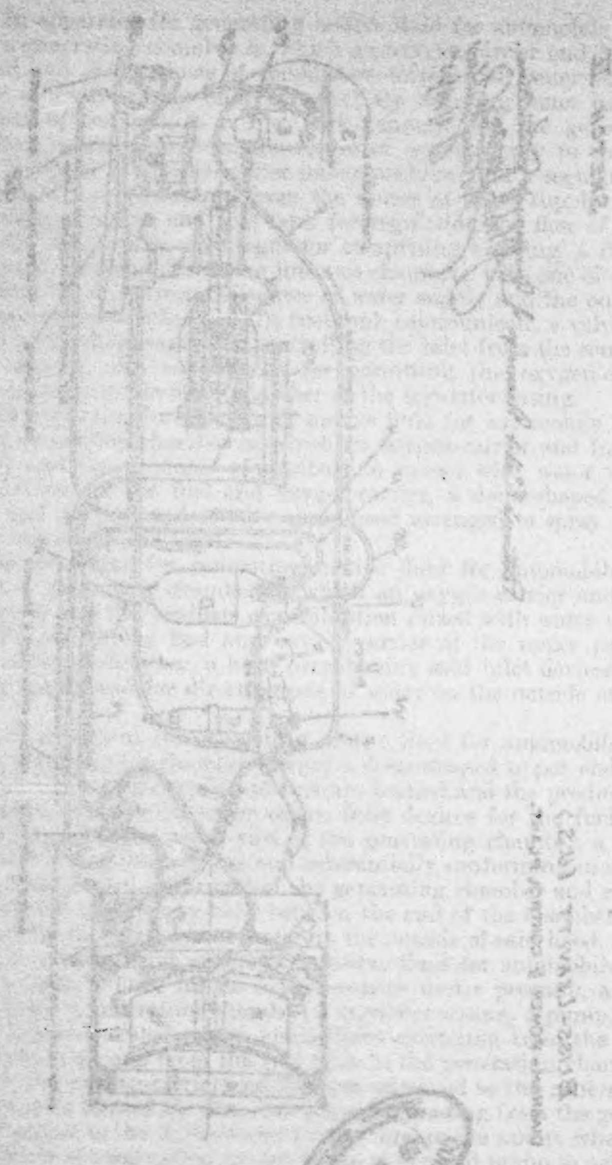
SKETCH II

BLISS-LEAVITT (U.S.)

DIAGRAM - POWER & CONTROL PLANT.

Petitioner's Exhibit. Drawing of Component [illegible].
John A. Swane
Notary Public
1/28/15.





carrier connections to the regulator casing, and mechanism within the regulator casing and actuated by the pressure of the oxygen-carrier for controlling the inlet from the pump.

12. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, a tank for an oxygen-carrier under pressure, a water supply, a fuel supply, a conduit leading from the oxygen-carrier tank to the combustion chamber, a second conduit through which the pressure of the oxygen-carrier is applied to the water supply, valve mechanism controlling said conduits, a conduit leading from the water supply to the fuel supply, and connections through which the fuel and water may freely pass under the pressure of the oxygen-carrier into the generating chamber, whereby the water and fuel feed to the generator, depends at all times upon the pressure of the oxygen-carrier, and the feed of fuel is dependent upon the pressure of the water supply.

13. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, a tank for an oxygen-carrier under pressure, a conduit including a control valve through which the oxygen-carrier may pass to the generating chamber whenever the control valve is open, a water supply, a fuel supply, a second conduit likewise controlled by said valve and through which the pressure of the oxygen-carrier is applied to the fuel and water supply, and conduits through which the fuel and water may freely pass, under such pressure, into the generating chamber, whereby the water and fuel feed depends at all times upon the pressure of the oxygen-carrier.

In testimony whereof I affix my signature, in presence of two witnesses. Gregory Caldwell Davison. Witnesses: F. L. Brake, W. D. Fesler.

Exhibit III

(Here follows diagram marked page 42.)

43 High-pressure air, at an initial pressure of about 2,250 pounds per square inch, is carried in the storage tank A, fuel is carried in the tank P, and water in the space in tank O not taken up by the fuel tank P suspended therein. Upon the launching of the torpedo a starting or control valve in pipe B is tripped and opened, allowing high-pressure air to flow from the tank A through the pipe B to the reducing valve C, where the pressure is reduced to and maintained at a practically uniform pressure of about 350 pounds per square inch throughout the run of the torpedo, a helical spring in the lower part of the reducing valve being set to secure and maintain the desired reduced and constant pressure.

Pipes F and L conduct high-pressure air from the high-pressure side of the reducing valve to the starting and distance gearing and to the gyroscope, respectively; and another pipe, marked "H. P. Air," leads from the high-pressure side of the reducing valve to the

pistol U, which is an ignition device to start combustion in the generating chamber D.

The feed of fuel and water into the combustion and generating chamber D is effected by the pressure in the fuel and water tanks of low-pressure air conducted thereto from the low-pressure side of the reducing valve C by the pipe G and its branches H and J, the water and fuel being forced from said tanks to the chamber D through the pipes M and N, respectively, to permit which the pressure of the air in said chamber D is reduced some 40 or 50 pounds below the pressure of the air in the low-pressure side of the reducing valve and in the water and fuel tanks. This additional reduction in pressure is effected by a restriction in the passage R, conducting the air from the reducing valve to said chamber D. The difference between the pressure in the water and fuel tanks and the pressure in the generating chamber D is also slightly increased by a Pitot pressure in the pipe G conveying compressed air to the water and fuel tanks.

The fuel is sprayed into the upper part of the combustion and generating chamber so as to intermingle and produce a combustible mixture with the air admitted through perforations in the baffle plate in the upper part of the chamber, and the water is sprayed directly into said chamber, in the presence of the burning fuel, and there vaporized and mixed with the products of combustion.

44 VIII. JUDGMENT OF THE COURT.

[Filed June 26, 1922.]

At a Court of Claims held in the City of Washington on the 26th day of June, A. D. 1922, judgment was ordered to be entered as follows:

The Court, upon due consideration of the premises find in favor of the defendant, and do order, adjudge and decree that the plaintiff, as aforesaid, is not entitled to recover and shall not have and recover any sum in this action of and from the United States; and that the petition herein be and the same hereby is dismissed; And it is further ordered, adjudged and decreed, that the United States shall have and recover of and from the plaintiff, as aforesaid, the sum of Six Hundred and Five Dollars and thirty-four cents ($605.34), the cost of printing the record in this court, to be collected by the clerk as provided by law. By the Court.

IX. PROCEEDINGS AFTER THE ENTRY OF JUDGMENT.

On July 18, 1922, the plaintiff filed a motion to amend findings of fact filed June 26, 1922. Said motion was overruled by the Court October 16, 1922.

On September 30, 1922, the plaintiff filed a motion for leave to file a motion for amendment of findings. Said motion was overruled by the Court October 16, 1922.

45 **X. PLAINTIFF'S APPLICATION FOR AND ALLOWANCE OF AN APPEAL.**

[Filed Sept. 22, 1922.]

From the decision and judgment rendered in the above entitled cause on the 26th day of June, 1922, in favor of the defendants, the plaintiff, on the 22nd day of September, 1922, makes application for, and gives notice of, an appeal to the Supreme Court of the United States. The Electric Boat Company, by Pennie, Davis, Marvin & Edmonds. Dated: New York, N. Y. September 22, 1922.

Filed, Court of Claims, September 23, 1922.
Ordered: That the above appeal be allowed as prayed for. October 16, 1922. By the Court.

46 Court of Claims.

[Title omitted.]

I, F. C. Kleinschmidt, Assistant Clerk Court of Claims, certify that the foregoing are true transcripts of the pleadings in the above-entitled cause; of the argument and submission of case; of the findings of fact, conclusions of law and opinion per curiam; of the judgment of the Court; of the plaintiff's application for and the allowance of an appeal to the Supreme Court of the United States.

In testimony whereof I have hereunto set my hand and affixed the seal of said Court at Washington City this Third day of November, A. D., 1922. [Seal of Court of Claims.] F. C. Kleinschmidt, Assistant Clerk Court of Claims.

Endorsed on cover: File No. 29,265. Court of Claims. Term No. 715. Electric Boat Company, appellant, vs. The United States. Filed November 29th, 1922. File No. 29,265.

(8468)

ELECTRIC BOAT COMPANY, APPELLANT

vs.

THE UNITED STATES

APPEAL FROM THE COURT OF CLAIMS

(29,265)

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1923

No. 159

ELECTRIC BOAT COMPANY, APPELLANT,

vs.

THE UNITED STATES

APPEAL FROM THE COURT OF CLAIMS

INDEX

JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., NOVEMBER 16, 1923

[fol. 34] SUPREME COURT OF THE UNITED STATES

October Term 1923

No. 159

Electric Boat Company, Appellant,

vs.

The United States, Appellee

Stipulation for Addition to Record

It is hereby stipulated and agreed by and between counsel for the parties hereto that Exhibits B-1, B-2 and B-3 referred to in Finding XIII of the Findings of Fact, and Exhibits C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8, C-9, C-10, C-11, C-12, C-13, C-14 and C-15 referred to in Finding XIV of the Findings of Fact, be added to the record herein on appeal from the judgment of the United States Court of Claims.

Dean S. Edmonds, Counsel for Appellant. James M. Beck, Solicitor General, Counsel for Appellee. Dated, November 7, 1923.

[fol. 35] In the United States Supreme Court

Washington, D. C.

[Title omitted]

Stipulation to Omit Parts of Record

It is hereby stipulated and agreed by and between counsel for the parties hereto that Exhibits C-1, C-2, C-3, C-4, C-6 and C-9, referred to in Finding XIV of the Findings of Fact and which were inserted in the record by stipulation to that effect and dated November 7th, 1923, be omitted from the record herein on appeal from the judgment of the United States Court of Claims.

Dean S. Edmonds, Counsel for Appellant. James M. Beck, Counsel for Appellee. Dated November 13th, 1923.

[fol. 36] In the United States Supreme Court

[Title omitted]

Stipulation re Translation

It is hereby stipulated and agreed by and between counsel for the parties hereto that the specification of British patent to Gesztesy

No. 18,241 of 1908 forming Exhibit C-12 shall be accepted as a translation of the specification of French patent to Gesztesy No. 393,324, forming Exhibit C-13.

It is further stipulated that the document annexed hereto is an accurate translation of the article published in Revista Maritima Braziliera for January, 1908, forming Exhibit C-14.

Dean S. Edmonds, Counsel for Appellant. James M. Beck, Solicitor General Counsel for Appellee. Dated November 7, 1923.

[fol. 37] GESZTEZY AIR WARMER FOR TORPEDOES

Of the apparatus intended for warming the air during the course of the torpedo and at present undergoing experiment at the Whitehead firm, it appears to us that the warmer invented by First lieutenant Gesztezy of the Austrian Navy will be the one preferred if the lauching tests have the same result as the preliminary experiments.

Up to the present the chief advantage of this apparatus over the Armstrong device is that it enables the engine of the torpedo to preserve all its bronze parts, which is not the case with the English warmer, in which, owing to its temperature, it becomes necessary to use steel in the pistons and distributing valves, so that the preservation of the motor is therefore difficult.

It is impossible for us to say wherein the operation of the Armstrong warmer consists, for the two torpedoes in which this apparatus is making its experiments are not dismounted in the sight of strangers.

However, as regards the Gesztezy warmer, the preliminary experiments with which were not secret and the diagram of which we were able to obtain, we shall do everything possible in order to give a general idea of its operation.

In the torpedo in which this warmer is mounted, it occupies the [fol. 38] compartment of the immersion regulators, the torpedo using the new immersion regulator placed in the engine compartment.

The purpose of the Gesztezy warmer is to quickly convert into steam the water contained in a reservoir, this steam proceeding together with the air to perform in the engine the rôle of warmed air.

The complete apparatus is composed as follows:

Warming apparatus proper E.
Retarding apparatus I.
Fuel (benzine) chamber F.
Water Chamber G.
Pistol H.

The warming apparatus is composed of the external bell T, having on the inside the cylindrical vessel t which limits the space for the combustion, the circular space d remaining between it and the external bell.

The internal vessel t diminishes in diameter at the lower part f, the large circular space c forming; at the bottom of t the tube a starts, terminating at the top by a cylindrical body g, where the elongated apertures h are situated.

By means of this body, the part of least diameter of t is divided into two parts, which are in communication solely by means of a small circular space, the upper part still remaining in communication with the space e by means of the holes i.

[fol. 39] In the bell T is the circular channel l, which is in communication with the water-conducting tube m, and by means of the holes n, with the space t.

To the warming apparatus is fixed the pistol H, where a small cartridge is detonated by percussion through the pressure of the air, brought to the pistol through the tube r.

The fuel and water chambers F and G are simple vessels in which are situated two tubes, one for the exit of the liquid and the other for the entrance of the air.

The pressure regulator D is the same one used in torpedoes.

The operation of the apparatus is as follows:

The air coming from the reservoir, upon finding the preservation and admission valves open, continues through the tube k to the pressure regulator, whence after being reduced to the proper pressure, it continues on to the retarding apparatus I; from here the tubes of small diameter p. o. r. conduct air to the water and combustion chambers and to the pistol.

When the work is terminated in the retarding apparatus the air goes on to the warmer through the tube k′, which terminates at the circular space e; here the air is divided into two parts, a small part [fol. 40] penetrating into the holes I, drawing away the benzine which quickly issues through the holes h, to the middle of the vessel t, where the mixture is ignited; the other part of the air continues through the space d to the upper part of the apparatus, carrying along and dispersing the water, which quickly issues through the holes n.

In the upper part of the apparatus there then takes place a union of the products of combustion with the air impregnated with water, the latter being instantaneously converted into steam and continuing on with the air to the engine, through the tube M.

The retarding apparatus, the internal view of which is not shown in the diagram, is the principal part of the apparatus, constituting, we heard a separate patent.

The purpose of this apparatus is only to permit a minimum pressure during the first moments of the course of the torpedo, increasing it gradually until the normal is reached.

The apparatus of Lieutenant Wesztezy possesses the following further advantages.

1. The first ignition of the mixture occurs with very small pressure, so that the sudden increase of pressure, due to the ignition can not have any disadvantageous consequence for the motor.

[fol. 41] 2. In launchings, the apparatus only enables the engine to work with full force after the torpedo has entered the water, so that the retarder now used becomes unnecessary.

3. By means of a suitable arrangement of the air-conducting tubes, it is possible to regulate exactly the moment of introduction of the benzine and of the water, as well as the instant of ignition.

The apparatus, as it is at present, weighs, with the chambers empty, 25 kg., the water chamber having a capacity of 8.5 l. and the benzine chamber 1.1 l.

Fiume, November, 1907.

L. Neves, Second Lieutenant.

(Here follow side folio pages 42-47, inclusive)

[fols. 48-59] Exhibits C-1 and C-2—Omitted in printing

(Here follows Exhibit C-3, marked side folio pages 60-66)

[fols. 67-71] Exhibit C-4—Omitted in printing

(Here follow side folio pages 72-74)

[Matter apparently omitted here.—Printer.]

[fol. 75] chambers and nozzles must be provided for the turbines, or the combustion chambers already provided are adapted to both methods of operation. This involves valves and connections which can rapidly change the operation of the turbines from the simple air oil cycle to that in which air or oxygen and oil are used, but in which water is added to make up for the air which would have been used to form the necessary balance of working fluid to enable the heat to be satisfactorily utilised.

The object of my methods for driving submarine or submersible boats is to enable the boat to be so fitted that the same driving mechanism which propels it on the surface is able to be used with the highest possible economy below water, in relation to the amount of propelling material which is stored and carried in the boat for under surface working.

The methods which I have described are such as to give great economy and therefore to give the largest number of horse-power-hours for the weight of stored material which is carried. A further great advantage in relation to other methods is that maximum horse-power may be obtained for moderate periods of time in running under water; or on the other hand the storage by this method and special adaptation to the turbine may be so used as to give considerably more than the surface working maximum for short periods of increased speed under water.

I may also use the same methods of operation for the propulsion of motor cars or other vehicles where it is desired to obtain great

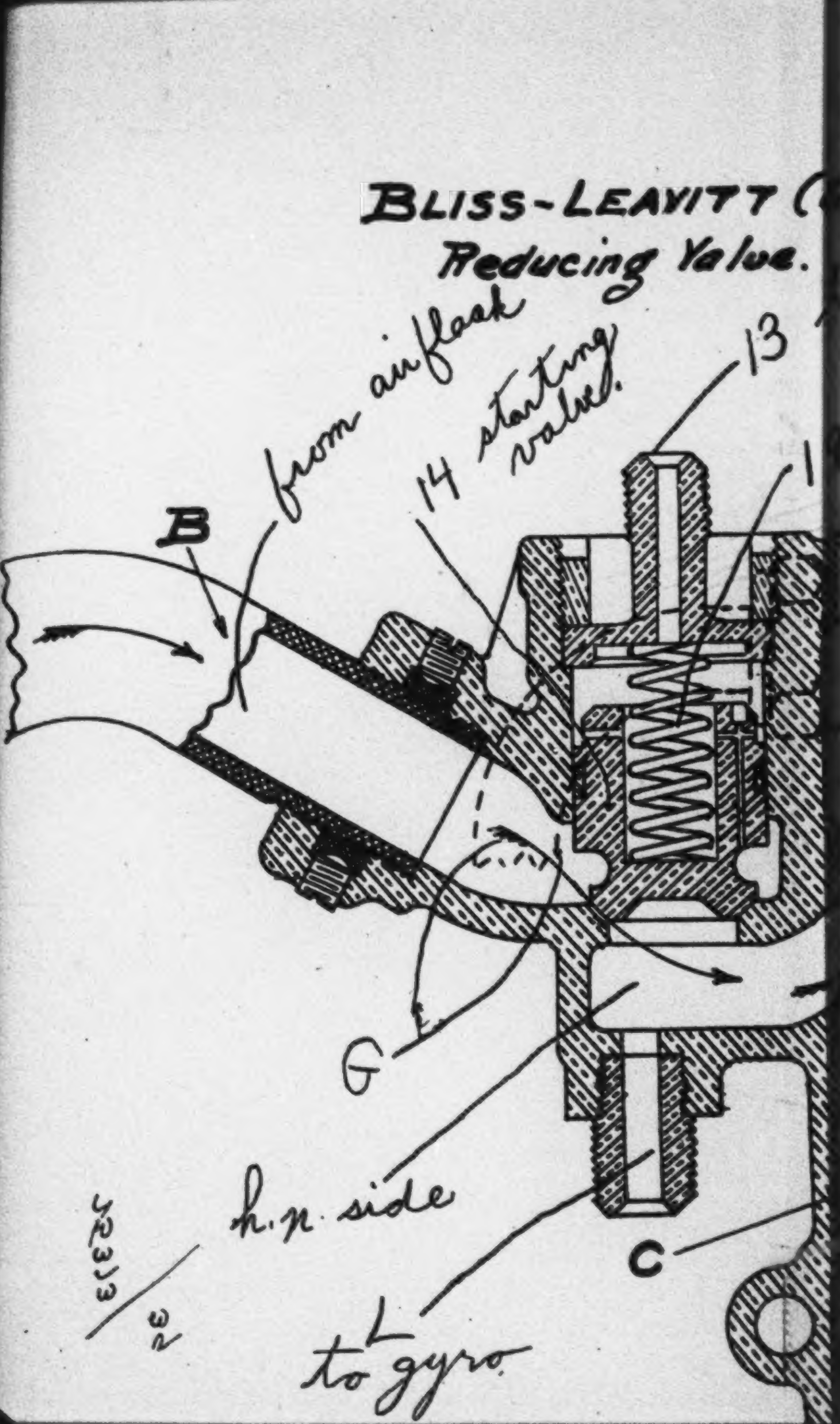
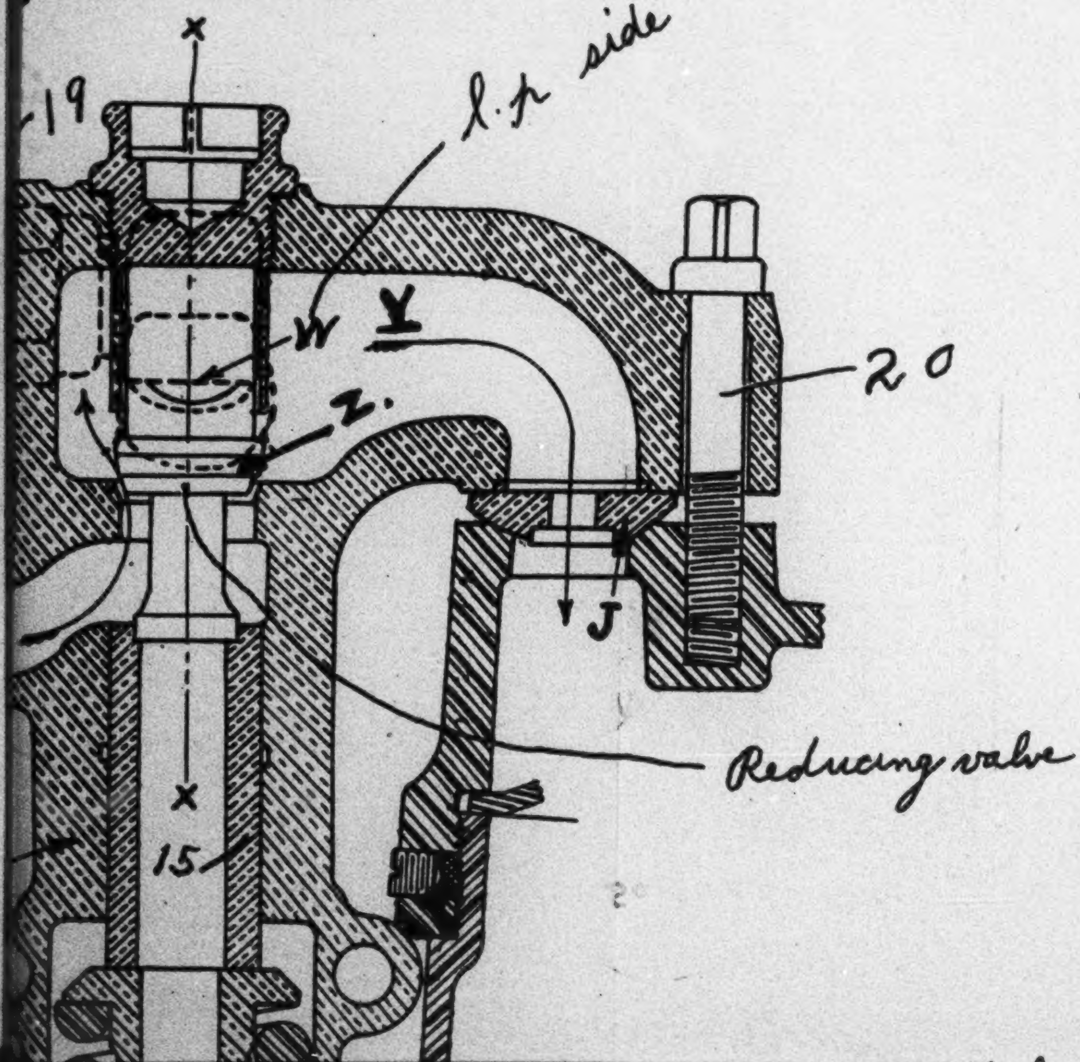

BLISS-LEAVITT (
Reducing Valve.
from air flask
14 starting valve.
13
1
B
G
h.p. side
C
L
to gyro.

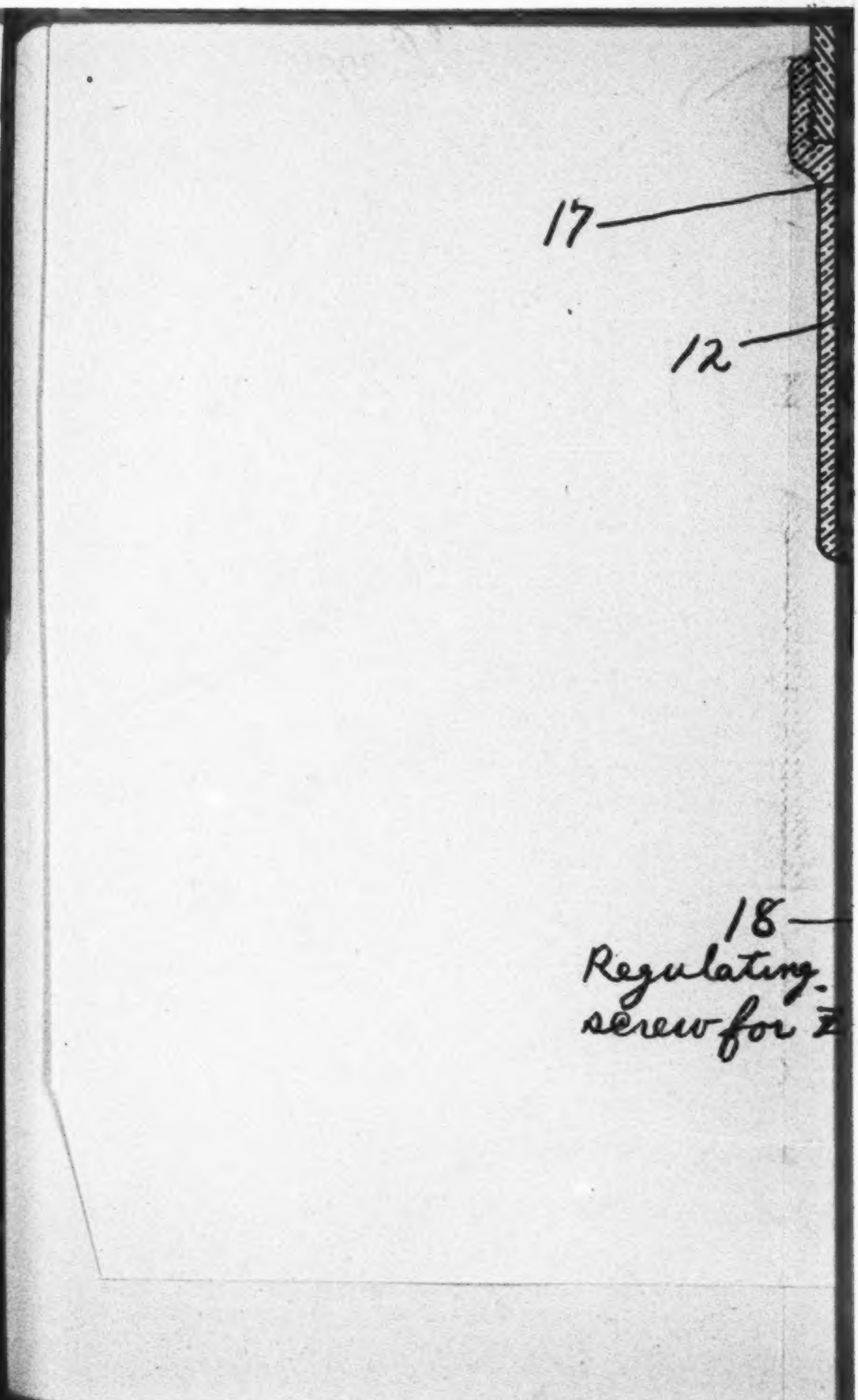
Exhibit B-1 to Court's findings

(U.S.)

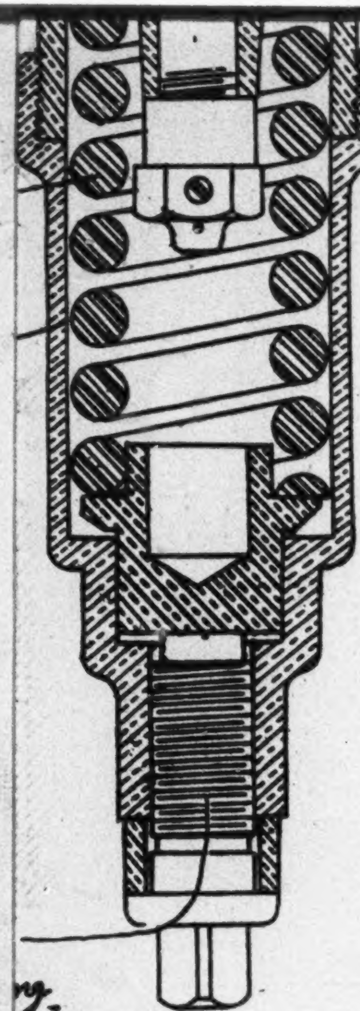
to starting & distance gear

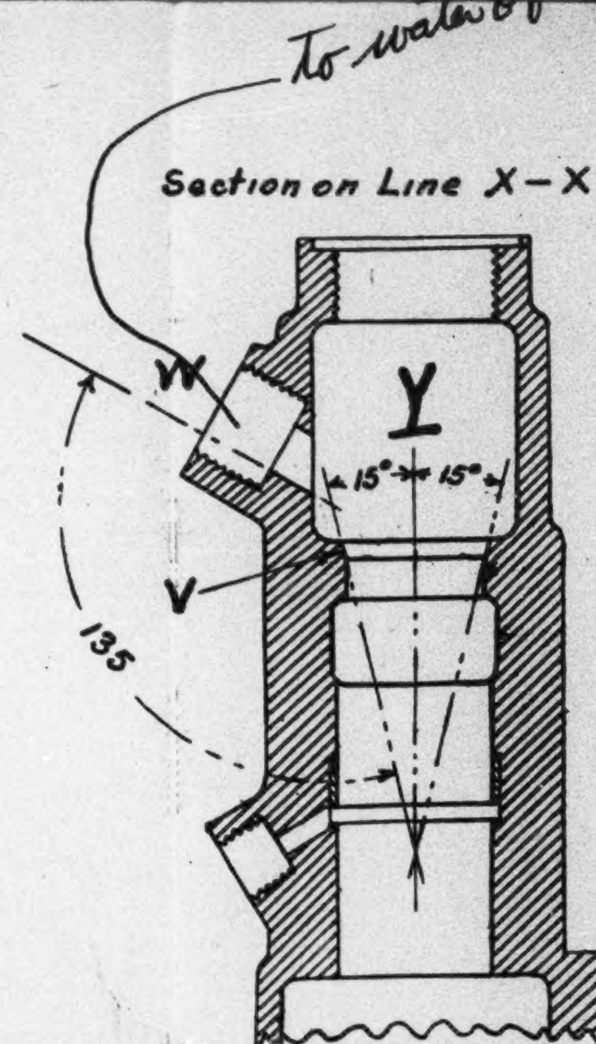
SKETCH IV.





17
12
18
Regulating-
screw for





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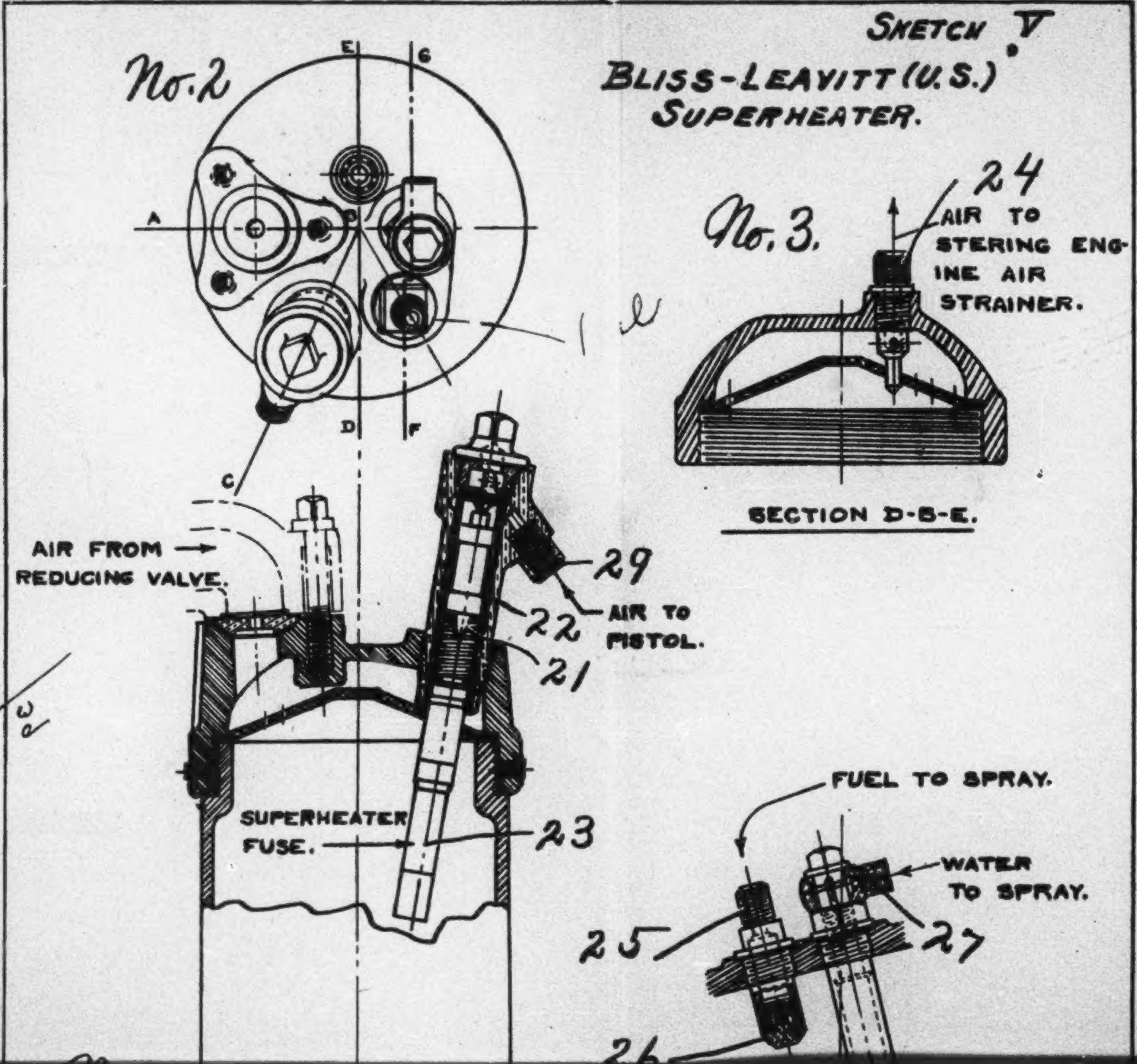
to Counté findings — Pages 44-45

SKETCH V.

BLISS-LEAVITT (U.S.) SUPERHEATER.



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to Courts findings

SKETCH VI

CROSS SECTION OF
BLISS-LEAVITT (U.S.) SUPERHEATER.

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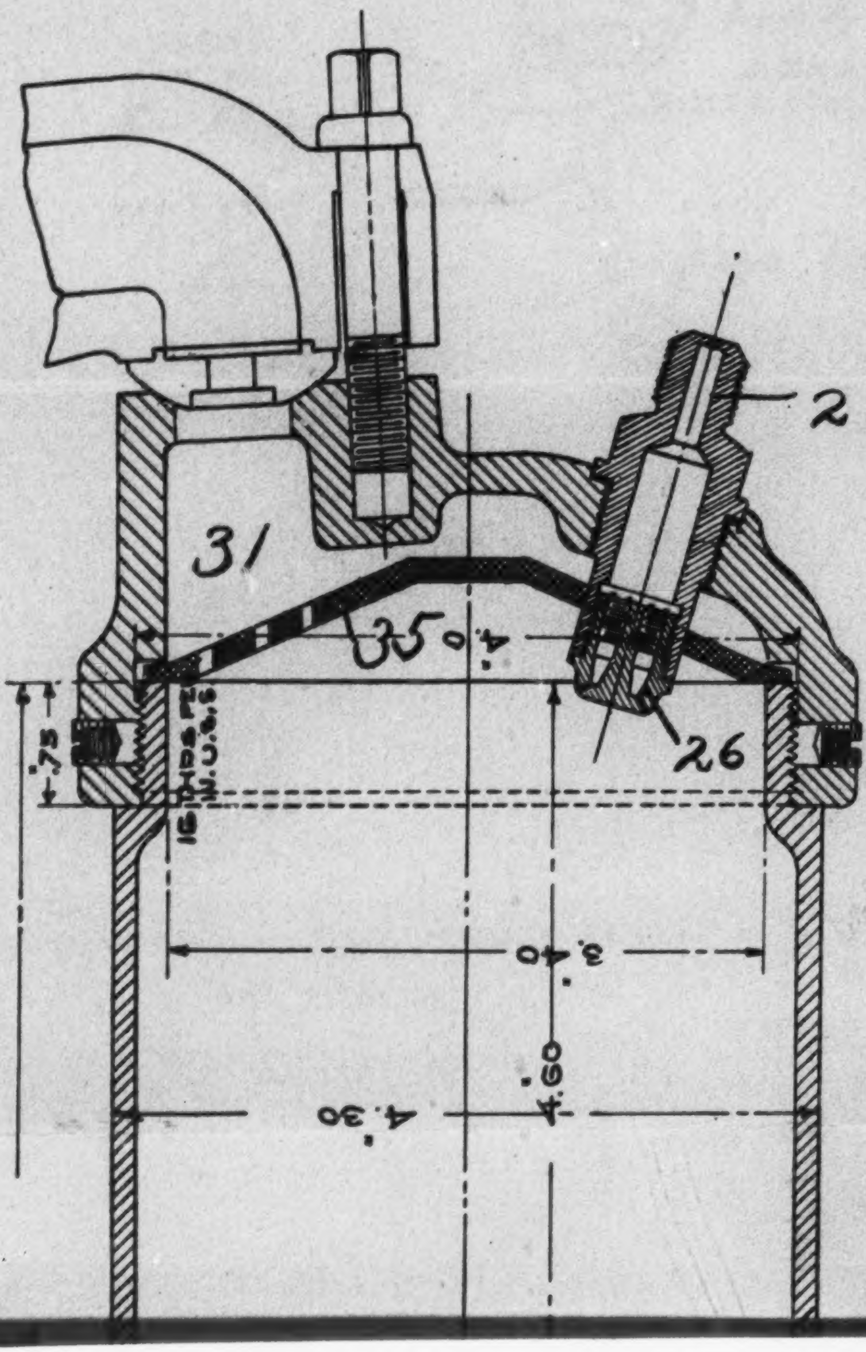

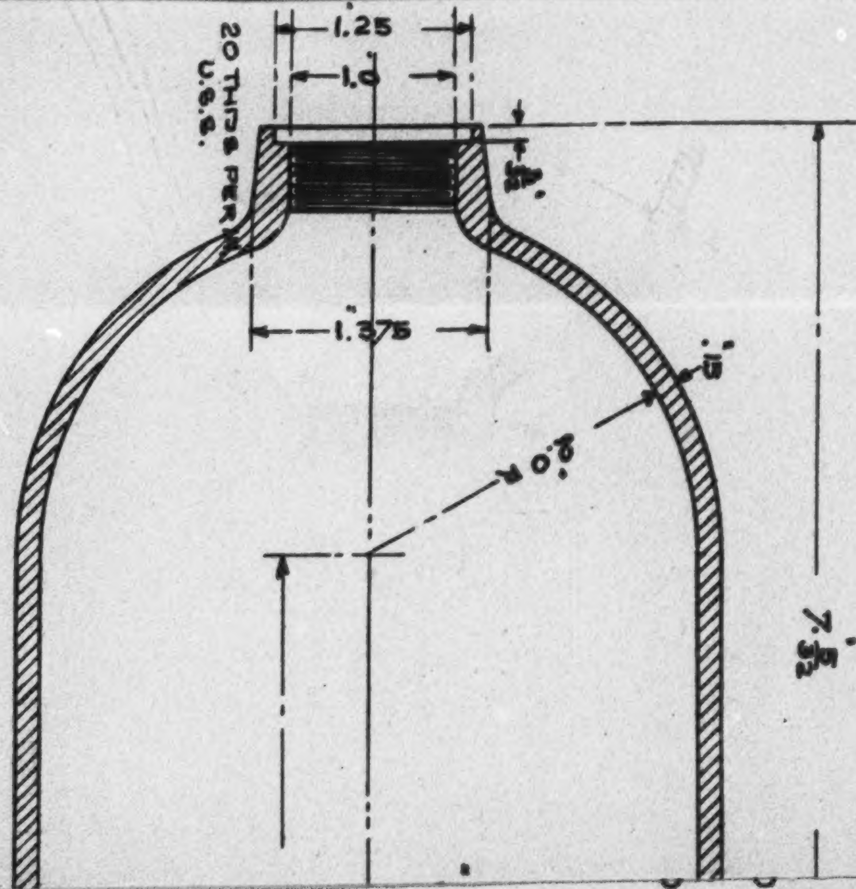
1.25"
1.0"
20 THDS PER IN.
U.S.S.
1.375"
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7 5/32"

No. 693,872. Patented Feb. 25, 1902.

F. M. LEAVITT.

PROPULSION OF TORPEDOES, &c., BY COMPRESSED AIR.

(Application filed Apr. 12, 1900.)

(No Model.) 2 Sheets—Sheet 2.

FIG 4.

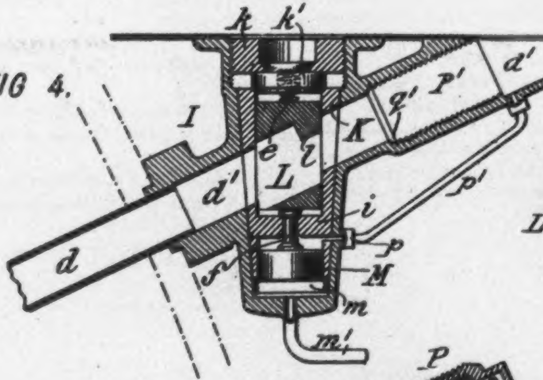


FIG. 7.

FIG. 5.

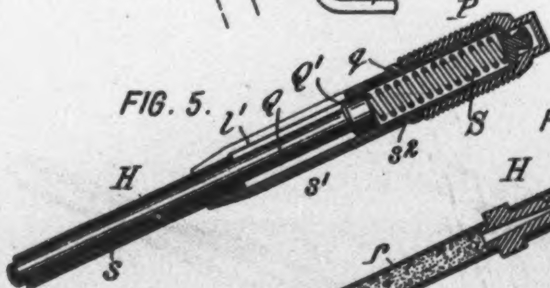


FIG. 6.

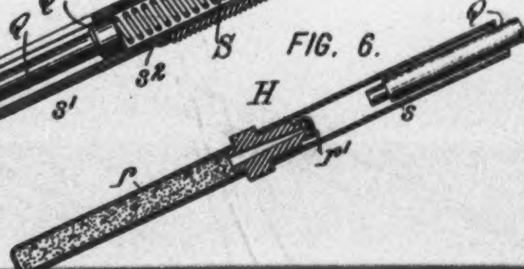


FIG. 8.

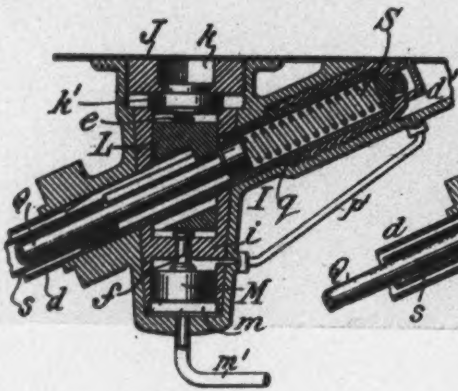
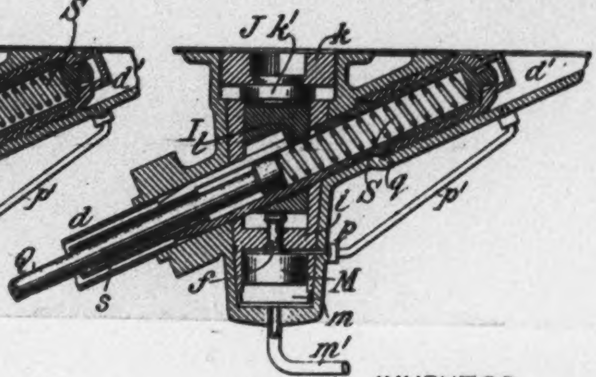


FIG. 9.



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Fred White
Thomas F. Wallace

INVENTOR:
Frank M. Leavitt,

By Attorneys,
Arthur C. Fraser & Co

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UNITED STATES PATENT OFFICE.

FRANK M. LEAVITT, OF BROOKLYN, NEW YORK, ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF WEST VIRGINIA.

PROPULSION OF TORPEDOES, &c., BY COMPRESSED AIR.

SPECIFICATION forming part of Letters Patent No. 693,872, dated February 25, 1902.

Application filed April 12, 1900. Serial No. 12,545. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. LEAVITT, a citizen of the United States, residing in the borough of Brooklyn, county of Kings, city and State of New York, have invented certain new and useful Improvements in the Propulsion of Torpedoes, &c., by Compressed Air, of which the following is a specification.

This invention provides improved means for storing and generating power from compressed air especially applicable for use in automobile torpedoes, although in part available for the propulsion of other moving bodies or vehicles by means of the power stored in a reservoir of air under very heavy pressure.

My invention is applicable where air is compressed to a high pressure in a reservoir or flask, being left stored therein until ready for use, whereupon the compressed air is passed through a pipe to the engine or motor which it drives. This is the system heretofore used for the propulsion of the Whitehead torpedo. According to my invention I apply heat to the compressed air in the reservoir by effecting a combustion therein of a suitable combustible material, such as a liquid hydrocarbon. Hence I provide a suitable charge of such combustible material, either in the compressed-air reservoir itself or preferably in a chamber communicating therewith, and when ready to utilize the power of the compressed air I ignite the combustible material and cause it to burn within the reservoir, so that its combustion serves to heat the air, and so increase its mechanical efficiency or capacity to do work. I effect the combustion of such material in a gradual and progressive manner, preferably by feeding it into the reservoir at a rate proportional to the fall of the pressure of air therein.

My invention also relates to means for igniting the combustible charge at or shortly after the turning on of compressed air to start the engine.

My invention also relates to means whereby the igniter is set in operation by the launching of the torpedo.

Having thus indicated the nature of my invention, I will proceed to explain the preferred mode of applying the same with reference to the accompanying drawings, which show it as applied in connection with an automobile torpedo, and wherein—

Figure 1 is a longitudinal mid-section of the torpedo, showing its propelling and starting mechanism. Fig. 2 is a fragmentary vertical section of the middle portion of Fig. 1, showing the parts more in detail. Fig. 3 is a transverse section on the line 3 3 in Fig. 2. Figs. 4, 5, and 6 are enlarged detail views of the igniting mechanism in vertical longitudinal mid-section. Fig. 7 is a rear elevation of the cocking-plunger removed. Figs. 8 and 9 are vertical longitudinal mid-sections of the igniting mechanism, showing it before and after action.

In the drawings let A designate a compressed-air reservoir or flask; B, an engine or motor to be driven by the compressed air; C, a chamber containing the combustible material, and a a pipe conveying compressed air from the reservoir to the motor. Preferably I place within the reservoir A a receptacle or vessel D, having an open top, but partly covered over by a hood E. A pipe b connects the bottom of the chamber C with the bottom of the receptacle D. The chamber C may be placed outside of the reservoir A, as shown, or, if preferred, it may be placed within the reservoir. In the former case the pipe b passes through the wall of the reservoir at some suitable point. The chamber C has a removable cap or filling-plug c, which may conveniently open through the shell of the torpedo, as shown in Fig. 3, and from which a tube c' leads down into the chamber C to a suitable depth, so that in filling the chamber with the combustible liquid an air-space will be left above the liquid, as at c^2. The pipe a is extended within the reservoir by a pipe a', connecting it with the hood E, so that the compressed air passing from the reservoir to the engine is compelled to circulate first into the chamber D, as indicated by the arrows in Fig. 2. Communicating with this pipe I have shown a valve F, which is the ordinary charging-valve for automobile torpedoes, through which compressed air is forced into the reservoir. The pipe a leads to any suitable valve

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for controlling the admission of compressed air to the engine in order to start the engine, and for this purpose I have shown at G the ordinary starting and pressure-reducing valve used in the Whitehead torpedo, with its starting arm or hook g, by which the valve is opened, in the act of launching the torpedo in the well-known manner; but any other valve or controlling means may be provided, my invention having no relation to this feature.

Before describing the igniting mechanism I will describe the operation of the system.

Before admitting air into the reservoir A and while its contents are at atmospheric pressure the plug c is removed, and the required quantity of alcohol or other suitable liquid hydrocarbon is poured into the chamber C, so as to fill it to the level x established by the lower end of the tube c', thereby leaving the air-space c^2 above the liquid. The pipe b extends so high that no liquid will run over into the receptacle D while filling the chamber C. The plug c is then tightly closed, and the reservoir being otherwise hermetically sealed air is pumped in through the valve F and pipes $a\ a'$ until the desired pressure is obtained—for example, fifteen hundred pounds per square inch—whereupon the admission-valve is closed or plugged, and the air thus introduced is left stored in the reservoir until power is to be applied. During this compression of the air as fast as its pressure exceeds that in the air-space c^2 it displaces the column of liquid in the tube b and bubbles up through the liquid in chamber C, so that the air in the space c^2 is compressed to the same pressure as that in the reservoir. When it is desired to apply the power thus stored, the starting-valve G is opened to admit the air to the motor B. As soon as the air begins to escape from the reservoir its pressure diminishes and the air in the space c^2 expands and gradually forces the liquid to flow from the chamber C into the receptacle D. In the system shown all the compressed air is assumed to be in a gaseous condition, and the reservoir comprises but one compartment, which serves for carrying both the store of compressed air and the receptacle D, instead of comprising two communicating compartments for the air and the receptacle D, respectively, as would be the case if the compression of the air had been carried to the point of liquidity. At a suitable time the combustible liquid is ignited in the receptacle D, (by any suitable igniting means, preferably that to be hereinafter described,) so that the liquid will burn in the receptacle D, its combustion being supported by the compressed air, so that it burns rapidly, and its heat being given up to the compressed air, so that the latter is increased in efficiency. The flames and hot gases resulting from this combustion mingle with the stream of air which is flowing into the receptacle D and out through the hood E and pipe a', the space around the hood being made amply wide to permit a flow of air so slow as to avoid blowing out the flame. By the gradual expansion of the air in the space c^2 as the pressure in the reservoir diminishes the combustible liquid is gradually and progressively fed into the receptacle D. Hence by suitably proportioning the volume of the air-space c^2 to the quantity of alcohol or other liquid the flow of the latter into the reservoir may be graduated to any proportionate rate desired. I prefer to adopt such proportion that the flow of alcohol shall be continuous during nearly the entire period of generation of power, so that the last of it will not be consumed until shortly before the pressure falls to a minimum at which it is no longer available for power purposes.

The energy stored in a given weight of air, or, in other words, its capacity to perform work, is in direct proportion to its absolute temperature. It therefore results from my invention that the efficiency of the air is so increased by the heat of combustion within the reservoir that a greater amount of power can be obtained with a given weight of air for the same period of time than the same weight of air can be made to produce when not heated. In practice I have found it practicable to add sufficient heat to increase the work done by the air about fifty per cent. My invention also avoids the disadvantage of the cooling of the engine and passages due to the expansion of the compressed air.

I will now describe the igniting means.

I provide a tube d, leading through the reservoir from its exterior to the receptacle D, through which tube I may introduce an igniter H, which is shown partly in dotted lines in Fig. 2 and which in its preferred form is shown in detail removed in Figs. 5 and 6. At the outer end of the tube d I provide a lock or cocking mechanism which as a whole is designated J. This mechanism is contained within a shell I, (shown best in Fig. 4,) which is adapted to withstand the heavy pressure and provides a means for closing the outer end of the tube d against this pressure. Within this shell is fitted a plug or casing K, which is preferably coned exteriorly and is ground to fit a coned socket in the shell I, so as to make an air-tight joint. In the upper part of this plug K is a cylindrical chamber in which moves a plunger L. (Shown separately in Fig. 7.) In the lower part of the plug is formed a cylindrical chamber in which moves a piston M, these chambers being separated by a partition i. The plug K is held down within the shell I by a screw-plug k, which screws into a threaded socket in the shell I and carries a disk or cap k', which makes a tight joint with the top of the plug K, so that air cannot escape from the interior of this plug. The plunger L is pressed down by a spring e, seated within the cap k'. Through the partition i passes a rod or valve-stem f. This stem has at its upper end a coned valve or head which when it is down seats against a

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coned seat in the upper part of the partition *i*, and at its lower end it carries a coned valve which when it is moved up seats in a coned seat formed at the lower side of this partition, thereby preventing leakage of air around the stem when it is in either position. The chamber *m* beneath the piston M communicates by a pipe *m'* with the compressed-air conduit at any point between the valve G and the engine B—as, for example, with the valve-chest of the engine—as shown in Fig. 1, so that when air is turned onto the engine it will flow back through the pipe *m'* and force up the piston M. The chamber above this piston is vented to the outer air by a passage *p*, which is preferably led by a pipe *p'* to an outlet beyond the igniting mechanism, as shown. The tube *d* is continued through the shell I by an oblique passage *d'* therein and in the plug K, as shown in Fig. 4, this passage leading to the exterior. Through this bore or passage the igniter H is inserted. This igniter is tubular and has a flange *g*, which is ground to a tight fit with a shoulder *g'* in the shell I, and when the igniter is in place it is forced tightly against this shoulder by means of a cap or screw-plug P, which screws into a threaded socket P' in the shell I, so that air cannot escape around the igniter. The igniter is preferably a percussion fuse or primer of the construction shown in Figs. 5 and 6. It carries at its lower end a cartridge *r*, containing a slow-burning powder or other suitable combustible, which when the igniter is in place projects within the receptacle D, as shown in Fig. 2. An ordinary percussion-cap *r'* serves for igniting this cartridge. The cartridge is carried at the end of a tube *s*, which passes through the tube *d* and at its upper end is joined to a tubular shell *s'*, Fig. 5, of larger bore, which preferably is made in two sections, its upper part *s²* forming a cap. A rod Q, forming a firing pin or hammer, is arranged to slide in the tube *s* and has at its upper end an enlarged head Q', which slides in the enlarged bore of the sleeve *s'*. A stiff spring S presses against this head, being housed within the cap *s²*. The hammer is held elevated or retracted by the plunger L, which acts as a trigger and which has a tooth or sear *l*, which projects through a slot *l'* in the upper side of the sleeve *s'*, Fig. 5, and engages the head Q' in the manner shown in Fig. 8, where the hammer is cocked, its spring S being compressed. In introducing the igniter it is passed down through the passage *d'* until the sear *l* of the plunger, which is pressed down by its spring *e* to the position shown in Fig. 4, catches the head Q', whereupon the cap P is screwed in and forces down the igniter until its flange *g* seats against the shoulder *g'*. In this operation the hammer, being held stationary by the sear, the spring S is compressed, as shown in Fig. 8.

In operation the launching of the torpedo throws the hook *g* into position to open the starting-valve G, which admits air-pressure to the engine and also admits compressed air through the tube *m'* to force up the piston M, which, acting through its stem *f*, pushes up the plunger L, and thereby withdraws the sear *l* and releases the hammer, which is forcibly thrown down by its spring S to the position shown in Fig. 9, so that its lower end strikes the cap *r'* and ignites the cartridge, which in turn ignites the combustible material in the receptacle D. The cartridge *r* is slow-burning, so as to insure that it shall burn long enough so that the fall of pressure in reservoir A shall have started the outflow of alcohol from the chamber C into the receptacle D, so as to be ignited by the cartridge, after which the alcohol enters the receptacle D at a uniform rate and burns as it enters. After the operation is completed the apparatus may be prepared for another operation by first letting any remaining air escape from the reservoir A, then unscrewing the cap P and removing the igniter H, applying thereto a new cartridge *r* and percussion-cap *r'*, and then reinserting the igniter and cocking it, as before described. A fresh charge of combustible liquid is introduced into C before again pumping in air.

My invention is not limited to the use of a liquid hydrocarbon, such as alcohol, as a compressed combustible gas may be used or even a solid combustible material.

My invention may be greatly modified in its practical application, and I do not limit myself to any one means of applying my invention. I prefer the igniting means herein described; but other igniting means may be used—as, for example, an electric fuse.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. In an automobile torpedo, the combination with means for storing fluid under pressure, an engine driven by such fluid, and means for starting the engine upon the launching of the torpedo, of means for heating the fluid supplied to the engine, and means for starting the action of said heating means adapted to be set in operation by the launching of the torpedo.

2. In an automobile torpedo, the combination with means for storing fluid under pressure, an engine driven by such fluid, and means for starting the engine upon the launching of the torpedo, of a heater in which a combustible is burned for heating the fluid supplied to the engine, an igniter adapted to ignite said combustible, and means set in operation by the launching of the torpedo for operating said igniter.

3. In an automobile torpedo, the combination with means for storing fluid under pressure, an engine driven by such fluid, and a starting-valve for admitting such fluid to the engine on the launching of the torpedo, of a heater in which a combustible is burned for heating the fluid supplied to the engine, an igniter adapted to ignite said combustible,

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and means set in operation by the opening of said valve for operating said igniter.

4. In an automobile torpedo the combination with a compressed-air reservoir, an engine, and means for starting the engine upon the launching of the torpedo, of an igniter adapted to ignite a combustible within the body of stored compressed air, and means set in operation by the launching of the torpedo for operating said igniter.

5. In an automobile torpedo the combination with a compressed-air reservoir, an engine, and a starting-valve for admitting compressed air to the engine on the launching of the torpedo, of an igniter adapted to ignite a combustible within the body of stored compressed air, and means set in operation by the opening of said valve for operating said igniter.

6. In an automobile torpedo the combination with a compressed-air reservoir, an engine, and means for starting the engine upon the launching of the torpedo, an igniter adapted to ignite a combustible within the body of stored compressed air and a fluid-pressure device for operating said igniter adapted to receive compressed air upon the launching of the torpedo.

7. In an automobile torpedo the combination with a compressed-air reservoir, an engine, and a starting-valve for admitting compressed air to the engine on the launching of the torpedo, of an igniter adapted to ignite a combustible within the body of stored compressed air and a fluid-pressure device for operating said igniter connected beyond said valve to receive compressed air upon the opening of said valve.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

FRANK M. LEAVITT.

Witnesses:
E. S. PORTER,
M. ARONSON.

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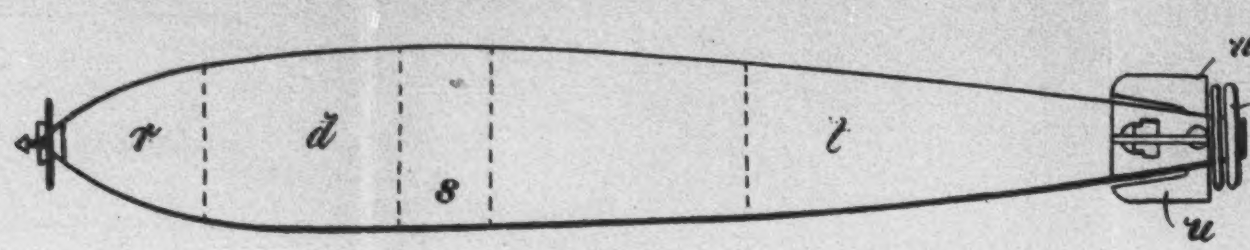
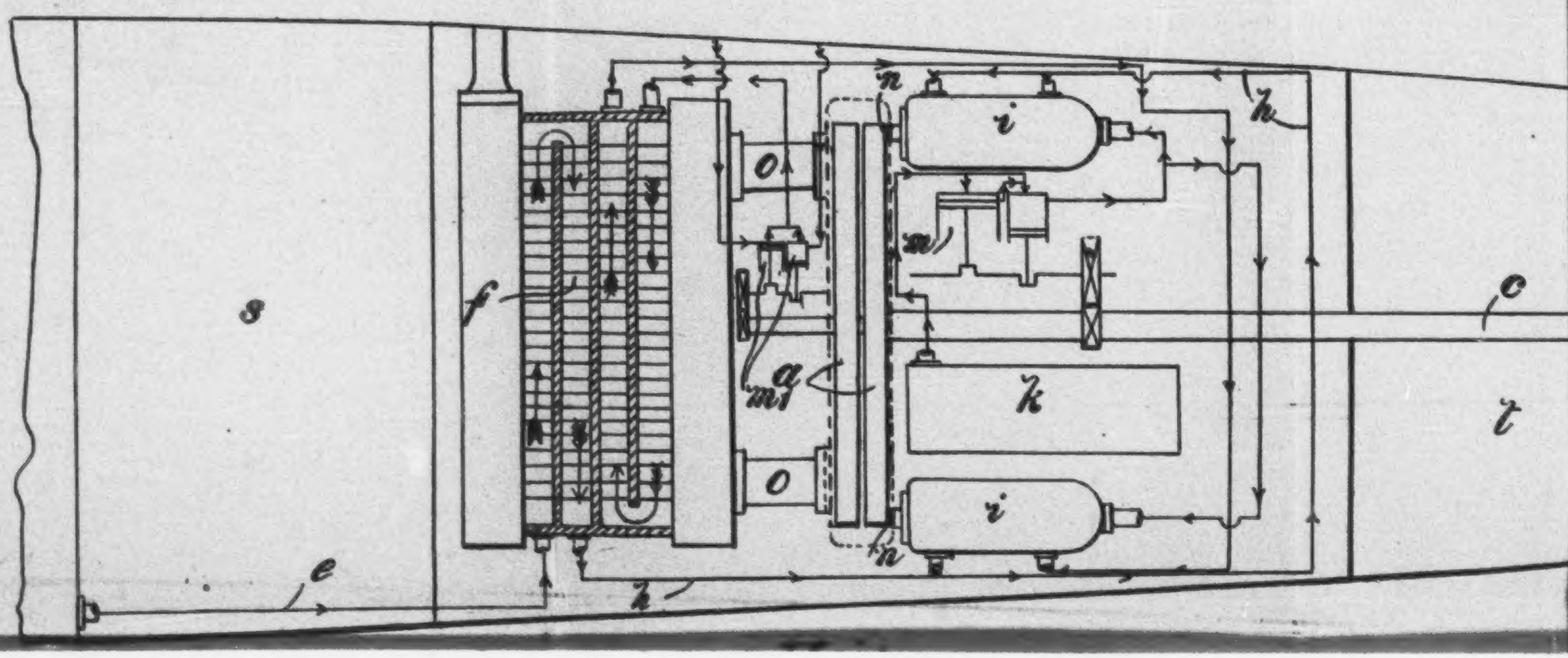


Fig. 1.



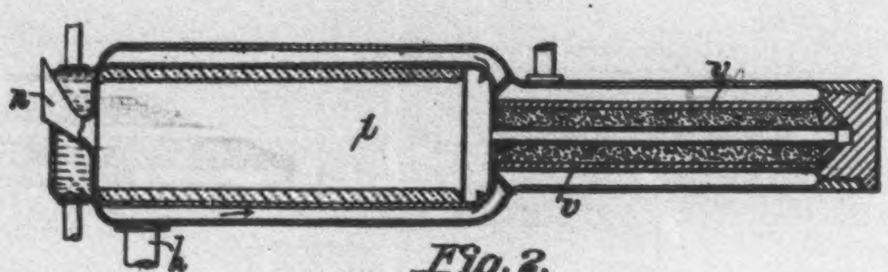


Fig. 2.

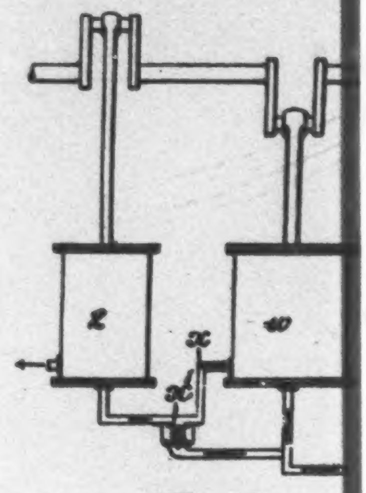


Fig. 3.

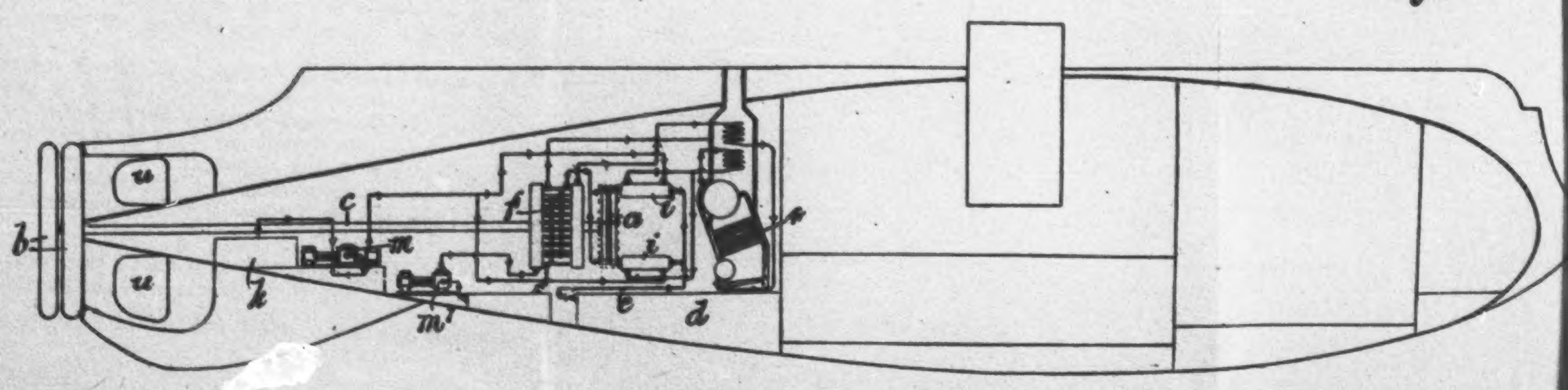
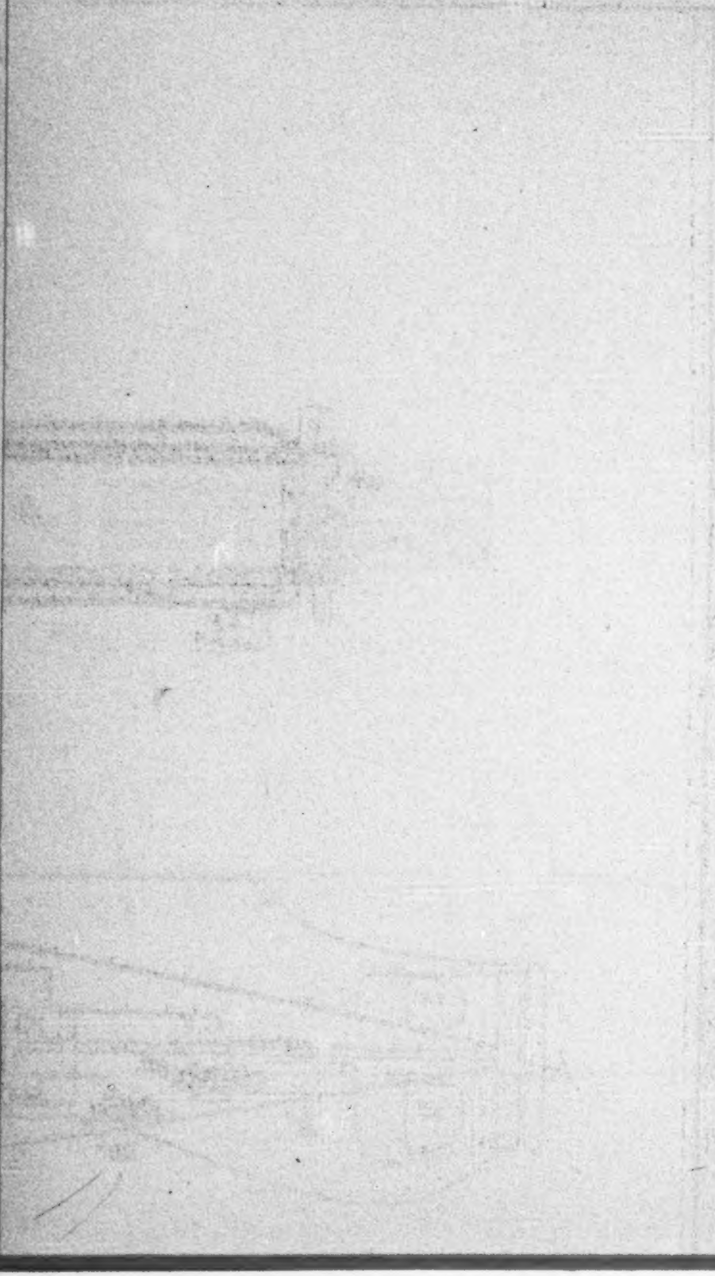


Fig. 4.



simplicity. These may be worked in other respects according to Application No. 1409 of 1904 already filed by me; the difference, however, being that instead of carrying a compressor, they carry a store of air or oxygen in the liquid or pressure form together with sufficient water to form the inert part of the working fluid, the exhaust however after passing through the regenerator being finally cooled in a condenser, so as to recover the water as far as possible for future use in the cycle. By means of carrying compressed oxygen, in which oil is burned and using water, which is dealt with as already explained, I am enabled for the weight carried to get a very large number of horse-power-hours, and by means of a very simple and durable plant to get results much better than can be obtained, as regards weight and the distance travelled, by means of accumulator traction.

Dated this 25th day of April, 1904.

Marks & Clerk, 18, Southampton Buildings, London, W. C., 13, Temple Street, Birmingham, and 30, Cross Street, Manchester, Agents.

Complete Specification

Improvements in and Relating to Turbine Installations for Propulsive Purposes

I, Sebastian Ziani de Ferranti, Engineer and Electrician, of 31 Lyndhurst Road, Hampstead, London, N. W., do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention has for its object to effect improvements in turbine installations so as to make them especially suitable to the propulsion of motor torpedoes, submarine boats, and any boats or vehicles where it is desired to have a simple plant working from stored energy not [fol. 76] only contained in the combustible, but also in the form of compressed air, compressed gas, liquid air or gas, or a compound such as slow burning powders and the like, which are capable of giving off heat energy without the employment of oxygen derived from the external air.

The invention thus consists in a turbine installation adapted to utilise a given store of energy without the employment of oxygen other than that contained in said store in a more efficient manner than has heretofore been possible by any known means.

The invention further consists in certain adjuncts necessary for working the above installation to the best advantage.

Referring to the accompanying drawings which form part of my specification,

Figure 1 is a longitudinal elevation of a Whitehead torpedo driven in accordance with the present invention,

Figure 1a being a section through the engine room to an enlarged scale;

Figure 2 shows a detail of a combustion chamber in which the air is heated by a slow burning powder or the like;

Figure 3 shows an elevation of a special form of pump, while

Figure 4 is a longitudinal elevation partly in section of a submarine driven in accordance with the present invention.

I wish it to be understood that the drawings accompanying this specification are of a diagrammatic nature throughout and are not to be taken as working drawings.

Where desirable corresponding elements in the different figures are denoted by the same reference symbols.

According to my invention, I construct torpedoes of the Whitehead type and instead of fitting them with engines as at present, I supply the motive power by means of a multiple impact turbine having two oppositely running wheels, a, of any known type, which drive screws, b, preferably without intermediate gearing in opposite directions on two concentric shafts, one of which is shown at c. The turbine wheels may be of any of the forms described in a Provisional Application for Patent made by me and numbered 9495 of April 25th, 1904. Instead of feeding these turbines with working fluid in the shape of cold air derived from the storage of compressed air, d, carried in the torpedo, I first lead the air by way of the pipe, e, to the regenerator, f, through which it passes and receives heat from the exhaust from the turbine; thence suitable pipes, h, lead to the combustion chambers, i, in which the air is raised to a high temperature such as 1200° C. or thereabouts by burning in it a small amount of oil or like fuel, for example, stored in a reservoir, k, the fuel being fed by means of a pump, m, driven from the turbine, into the combustion chamber, i, in the form of finely divided spray. The pump is of special construction in order to enable it accurately to supply the charge of oil or the like and will be described later in this specification. The action of the pump may be assisted by feeding the oil to it under pressure derived from the air so as to assist the positive action of the valves and therefore to give an accurate quantity of combustible; to carry this method into effect, it is merely necessary to adapt the oil reservoir to withstand high pressures and to lead a pipe from the compressed air store, d, to the upper part of the reservoir, k. As an alternative the pump, m, may be dispensed with and the oil forced into the combustion chamber entirely by the compressed air. In either case only sufficient oil is delivered to raise the temperature of the working fluid to a point such that after complete expansion, it will not act detrimentally upon the running blades of the turbine. I effect the complete expansion of the fluid in the combustion chamber from a high temperature and pressure down to a little above atmosphere pressure and a temperature of about 400° C. by passing it through the divergent expansion nozzles, n, during its passage through which its pressure energy is converted into kinetic energy. The jets issuing from the nozzles, n, then impinge upon the blades of the turbine wheels and are passed back-[fol. 77] wards and forwards a sufficient number of times to extract

sufficient of this velocity to ensure efficiency. The exhaust from the turbine I prefer to pass through the small regenerator, f, before mentioned by way of the exhaust pipes, o, thus serving to heat the air on its passage from the extra high pressure chamber, d, to the combustion chambers, i. Between the air chamber, d, and the turbine, a reducing valve and control gear such as are usually employed at the present time in Whitehead torpedoes may be fitted; other usual parts of this type of torpedo such as the explosive head, r, balance chamber, s, buoyancy chamber, t, and horizontal and vertical rudders, u, are indicated in Figure 1. It will be seen that on account of the greatly increased efficiency of the arrangement described above over those now in use, I am enabled to considerably reduce the volume of the air chamber, d.

Thus by the means described the compressed air is used on a highly advantageous cycle whereby about four times the horse-power-hours may be obtained in relation to using the air cold according to present practice, the fact of having air under pressure being taken advantage of for this purpose to give an internal combustion turbine of high efficiency.

According to another method I may supply the heat to the compressed air by means of a slow burning powder and I can do this (see Figure 2) by putting a charge of slow powder or like material, which may or may not contain a predetermined amount of water, into a tube or case, v, such as that containing a rocket, but of sufficient strength to resist the full pressure of the cycle. The end of this tube adjoins or projects into the heating chamber the hot gases from it mixing with the air flowing in from the jacket, as indicated by the arrows and heating it to the desired temperature. The mixture is then expanded in the nozzle and dealt with as above explained.

According to another method I replace the storage of compressed air by a storage of compressed oxygen. This when heated by burning in it oil or other suitable combustible, gives a much larger amount of energy than the air. On the other hand, the temperature given is very high, and the result from this combination is too small a quantity of high temperature working fluid to be capable of useful application. It is therefore essential with this method to introduce sufficient medium, which may be of an inert nature, to give the full amount of working fluid at a temperature not exceeding that which can be usefully dealt with that it is possible to get from the weight of oxygen and oil which can be carried. I accomplish this by means of introducing a fixed quantity of water, and mixing, evaporating and superheating this so as to produce the desired result. According to this method I let the discharge from the turbine wheels issue at the full temperature which these will stand for a short period. I pass this exhaust through a regenerator which is so arranged as to efficiently transmit its heat to the water to be used in the cycle. This regenerator in reality forms a partial boiler, as there is sufficient heat contained in the exhaust to heat the whole of the water up to the boiling point, and to evaporate about one-third of the whole at the working pressure. The water is forced through the regenerator

chamber at a high pressure, preferably twice that of the working fluid in the combustion chamber. It is then discharged by means of spray nozzles into the combustion chamber where it is atomised due to the high velocity of issuing through small orifices, and also due to the heat which it contains, which is sufficient to break it up into steam and so intimately mix it with the gases that complete evaporation takes place.

The heat contained in the water under pressure is sufficient to vaporise a portion of it. The steam thus formed internally atomises the remaining water most effectually thus greatly assisting complete evaporation by the hot gases and final mixture therewith.

This method may also be advantageously employed in the cycle when the heat is derived from slow burning powder or similar source of energy.

[fol. 78] The above cycle is generally similar to that described in my Patent Specification No. 13199/03, with reference to Figure 7, similar apparatus modified to meet the new conditions being employed to carrying it into effect. It will, however, be seen that whereas in my Specification, No. 13199/03, a compressor is needed as part of the complete plant, thereby giving rise to considerable negative work and loss of efficiency, in the present invention, this loss is done away with so far as the running of the torpedo is concerned, the whole object of my invention being to utilise a given store energy to the greatest advantage so that in the case of a torpedo, for example, a much greater range may be obtained for the same weight of working fluid or the same range as at present with a reduced weight of fluid.

According to a modification of this form of operation I may use a circulating pump attached to the evaporation chamber which is arranged to catch any liquid which falls therefrom and to force it, together with the rest of the water in the form of spray, again into the combustion chamber. This method is adopted in case the vaporisation of the water is not completed at the first passage into the heating chamber.

According to another method I may mix the water with the oxygen or with the oxygen and the oil, and force these into the combustion and evaporating chamber so that an intimate gas and spray mixture is formed which burns with a temperature not exceeding the maximum at which it is desired to work.

According to another method, instead of using liquid combustible I may store gas under pressure in a separate reservoir, to be burnt with the air or oxygen. Any suitable gas such as coal gas or enriched water gas may be used, or acetylene stored under pressure or stored under pressure in connection with being dissolved in acetone, in much the same way as has been employed for train lighting. In the case of both the combustible when in the form of gas and of the air or oxygen, I store these separately at high pressure and use suitable reducing valves which gives an approximately constant pressure in the working chamber.

I may apply the system where water is introduced and used as described, to motors in which the energy is obtained from stored air

under pressure, and oil or other fuel. In this case the full amount of fuel which the air will burn is introduced, and which without the addition of inert material would give too high a working temperature to be usefully employed. As seen in Figure 1, the water is pumped through the regenerator in parallel with the air by the pump m^1.

According to another method I may combine the above systems in the form of supplying the heat energy from a slow burning powder or material which contains its own elements of combustion and the inert body in the form of water pumped in as already described to the heating chamber. According to this last method I may pump the water through or around the chamber containing the slow burning powder or the like, so as to prevent any undue rise of temperature by transmission from the burning material.

Where the slow burning material can be supplied in the form of liquid, I prefer to mix the water with this and spray into the combustion chamber so as to get the most intimate possible mixture of the burning gases with the water, so as to obtain complete evaporation.

Where I use air or oxygen or the like as part of the motive fluid, I may carry this in the liquid form either in a vessel incapable of standing much pressure in which gas will be given off to the atmosphere due to evaporation, or in a vessel which will stand the full working pressure of the cycle, said pressure being used to force out a sufficient quantity of the liquid for vaporisation under pressure and use in the cycle. Where the liquid is contained without being under much pressure it is necessary to force it by means of a pump for the purpose of evaporation, and use in the cycle. The liquid may be evaporated in one part of the regenerator as above explained, the [fol. 79] other part being used for the purpose of raising the temperature and evaporating the portion of the water which is used as the inert medium. Or on the other hand, the exhaust gases may first heat up and evaporate the water and still contain sufficient heat energy to usefully vaporise the liquid to be converted into gas as already described.

Where I desire to keep such a store of liquid oxygen, liquid air or the like with the minimum vaporisation, I use the gas given off by the same to pass round a jacket adjoining the chamber containing it, for the purpose of keeping down the conduction of heat to the store from the external air or surroundings; in other words, this evaporation is used as a refrigerator to keep down the temperature.

It is obvious that modifications of the above class of operations may be introduced, and I do not confine myself to the exact methods which I have described herein. What, however, is common to all these methods is an immensely better use of the store of energy in the torpedoes than is practicable according to present methods, the turbine being specially useful in the form which I have described for taking advantage of the high temperatures which would be unworkable in an ordinary engine, as it is able to convert these temperatures into velocity and so work with medium temperatures on the moving parts.

The apparatus required to carry into effect the various modifica-

tions I have described is similar to that used in the various cycles of my Patents, Nos. 13199/03 and 1409/04; the operations of these cycles will be readily understood without further explanation in view of the detailed description given above with regard to Figure 1.

Where it is desired to deliver an accurate quantity of liquid, such as to the combustion or evaporation chamber of the turbine, in order to carry the working cycle into effect to the best advantage, I make a compound liquid pump. The larger or first cylinder, w, (see Figure 3) is made in the ordinary way and delivers through the pipe, x, at say two or three times atmospheric pressure. This has an overflow relief value, x^1. The second or smaller capacity cylinder, 2, has valves seated with strong springs, and water is forced in, following the piston from the first pressure chamber, thus ensuring a full charge per stroke, the surplus passing the relief valve, x^1, and if oil, being returned to the suction as indicated, the strong valve closing springs also prevent slip and an accurate amount of fluid of a predetermined amount is delivered.

I may apply these methods to the driving of the turbines of submarines or submersible boats when they are working under the surface. There are two forms of turbines which I prefer to use in connection with this invention. The first form employs as the working fluid steam superheated by internal combustion, as described in my Application for Patent No. 13199 of 1903.

According to the second method I employ an air internal combustion turbine as described in my Specification No. 1409 of 1904. Both these systems are further described and added to in my Application No. 9495 of April 25th 1904, which specification specially describes the particular form of turbine which I consider most suitable for application in the present case.

According to the first method, (see Figure 4), I may carry a store of compressed air, d, or preferably compressed oxygen. I also carry liquid combustible, k, preferably in the form of oil. In some cases I may also carry hot water at high temperature and pressure in insulated storage tanks or vessels; or I may so construct the boiler, 4, with sufficient extra water space to effect the same purpose. Where water is carried hot under pressure in the boiler or separate tank, I prefer to work the boiler at about 50% higher pressure than that at which steam is used in the internal superheating chamber, adjoining the turbine. The extra water carried may be used below the surface to give off steam which will be superheated by means of internal combustion as already described before being passed to the expanding nozzles. In some cases I may simply draw the hot water under [fol. 80] pressure from the store which is carried and use this, which will partially flash into steam in the combustion chamber atomised so as to mix most completely with the burning gases and pass into the nozzle in the form of highly superheated steam and products of combustion. In some cases I simply obtain the necessary heat from the compressed air or oxygen and oil which I carry in the boat, pumping water at high pressure through the regenerator and into the combustion and superheating chamber, the evaporation being thereby effected as already explained in the above cases referred to;

in all these cases the store of compressed fluid takes the place of the compressor in my previous patents above referred to.

The above arrangements are all for working under water but may also be used just before going under water or for running short distances on the surface where it is desired to emit no smoke from the boilers, which should be oil fired.

In some cases it may be advantageous to work boats of this class when using this cycle of operations, by means of compressed air obtained from a running compressor when on the surface, the power provided in the compressor being greater than would be required in the ordinary case and so dispensing with a separate boiler. In this case, the regenerator is made of ample capacity and the water pumped through it, during which operation, sufficient heat is given to raise the whole of the water to boiling point and also to evaporate one-third; this cycle has already been referred to as similar to that above described with reference to Figure 7 of my Patent Specification, No. 13199/03. This disposition of parts greatly assists in atomising the water when it is driven into the combustion chamber and obtaining a mixture so intimate with the burning gases that complete evaporation is obtained. The compressor according to this arrangement of parts is preferably driven from the turbine through a clutch, so that it may be disconnected for working under water and the store of air compressed by it utilised.

According to this method of operation, additional power can be obtained from the cycle by means of allowing the exhaust, consisting of steam and products of combustion, to evaporate water which is used in a condensing turbine, as described in my Patent Specification No. 13199/03, the evaporation taking place at or about atmospheric pressure. In this case it is desirable to instal- the turbines worked in this way on the main propeller shafts, so that the additional power may be obtained under water.

According to the second method, where I employ an internal combustion turbine such as I have already described in my various applications for patents mentioned herein (for example, No. 1409/04) for running on the surface, I may use the methods already described for under-water working. Thus when on the surface, the combustion chambers are fed with air from the compressor, while when below the surface, the compressor is preferably stopped—e. g., by unclutching it, if driven from the turbine—and the combustion chambers fed direct from the store. Either a separate set of chambers and nozzles is provided for the two methods of working or else the same combustion chambers are used in both cases. Suitable valves and connections of any known type are provided for rapidly changing the operation of the turbines from the simple air oil cycle for surface working to that in which air or oxygen previously stored and oil are used for under-water working, water being added in the case of stored oxygen as already fully explained above.

I may modify the above second method of operation by driving as a simple air turbine above water as already explained in which case sufficient air is compressed not only to burn the combustible but also to act as the inert matter to utilise properly the heat gen-

erated or I may draw a portion of the fluid to be compressed from the outside air sufficient for complete combustion, the balance of the working fluid being drawn from the exhaust after passing through a final cooler and after compression to the maximum pressure.

[fol. 81] For below water working the only change necessary is to replace the fresh air of the working fluid by air drawn from the pressure storage tanks or from a store of liquid air carried or by oxygen sufficient to burn the fuel, this oxygen being obtained either from cylinders of compressed gas or from a storage of more or less pure liquid oxygen carried in the vessel.

The advantage of this modification of my second method is that no supplementary or different combustion chamber and nozzle arrangements are required for under water working, the valve which cuts off the fresh air supply to the compressor being connected to open out the supply from the storage system. Supplementary compressing cylinders may be fitted to the ordinary working pumps or compressors according to the first and second methods in order to raise the air to storage pressure whilst working on the surface ready for operation under the surface.

The object of my methods of driving submarine or submersible boats is to enable the boat to be so fitted that the same driving mechanism which propels it on the surface is able to be used with the highest possible economy below water in relation to the amount of propelling material which is stored and carried in the boat for under surface working.

In order that some idea of the improved results likely to accrue from the use of my invention may be realised, I give here certain approximate relative figures for the case of a torpedo.

Thus, taking first the case of an ordinary Whitehead torpedo, I assume a certain definite weight is available for the store of compressed air and the metal shell or envelope containing it, and I represent the number of horse-power-hours obtainable from this weight by unity.

Then with the same weight available in each case;

(1) Using oil and excess of air injected into the combustion chamber, as described in my Application No. 1409/04, I obtain the comparative figure 4.6 as representing the number of horse-power-hours obtainable.

(2) Using oil and just sufficient air for combustion and water raised to the boiling point in the regenerator before injection into the combustion chamber, I obtain the figure 8.6.

(3) Using oil and just sufficient oxygen for combustion together with water, all of which is raised to the boiling point in the regenerator and 37% evaporated therein, I obtain the figure 30.2.

(4) Using the same media as in (2) but carrying the air in the liquid state, I obtain (a) with a double casing for the air, i. e., a refrigerating jacket as described above, the figure 18 and (b) with a single casing, the figure 25.1.

(5) Using the same media as in (3) but carrying the oxygen in the liquid state, I obtain (a) with a double casing i. e., a jacket, for the oxygen, the figure 52.5 and (b) with a single casing, the figure 69.6.

The methods which I have described are such as to give great economy and therefore to give the largest number of horse-power-hours for the weight of stored material which is carried. A further great advantage in relation to other methods is that maximum horse-power may be obtained for moderate periods of time in running under water; or on the other hand the storage by this method and special adaptation to the turbine may be so used as to give considerably more than the surface working maximum for short periods of increased speed under water.

I may also use the same methods of operation for the propulsion of motor cars or other vehicles where it is desired to obtain great simplicity. These may be worked in other respects according to Application No. 1409 of 1904 already filed by me; the difference, however, being that instead of carrying a compressor, they carry a store of air or oxygen in the liquid or pressure form together with sufficient water to form the inert part of the working fluid, the exhaust, however, after passing through the regenerator being finally cooled in a condenser, so as to recover the water as far as possible [fol. 82] for future use in the cycle. By means of carrying compressed oxygen, in which oil is burned and using water, which is dealt with as already explained, I am enabled for the weight carried to get a very large number of horse-power-hours, and by means of a very simple and durable plant to get results much better than can be obtained, as regards weight and distance travelled, by means of accumulator traction.

Although I have described three ways in which my invention may be carried into effect, viz., for driving torpedoes, submarines and submersibles, and road vehicles, I wish it to be understood that what I have described above as applying to one of the above may in some cases be applicable to another, and in the appended claims I have used the word "automotor" in its generic sense to include any or all of the above applications.

I also wish it to be understood that by the term "internal combustion turbine," I intend to include only those cases in which the energy derived from the combustion of the fuel is imparted to the working fluid previous to or during its expansion in the fixed parts of the turbine and not on its passage through the blades.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In an automotor, the use of a turbine fed from energy stored in fuel such as oil or gas under pressure and an oxydiser such as air or oxygen stored under pressure or in liquid form, substantially as and for the purpose described.

2. In an automotor such as claimed in Claim 1, adding to the working fluid inert matter such as water carried in a storage tank

or pumped in from the outside, substantially as and for the purpose described.

3. In an automotor such as claimed in Claims 1 or 2, adding inert matter to the cycle in the form of exhaust products, substantially as and for the purpose described.

4. An automotor turbine driven boat which when working on the surface uses air pumped from the outside and which when under water uses stored air, oxygen or like oxydiser to burn the fuel used in the cycle, substantially as described.

5. In an automotor boat such as claimed in Claim 4, adding inert matter to the working fluid in the form of water or of products of combustion, substantially as described.

6. In a turbine driven automotor, supplying the working fluid by the burning of self-oxydising combustible such as slow burning powder, the gases from which are expanded through nozzles and form the working fluid, substantially as and for the purpose described.

7. In an automotor such as claimed in Claim 6, adding inert matter to form part of the working fluid, substantially as and for the purpose described.

8. In automotors such as previously claimed, the use of a regenerator for one or more of the elements forming the working fluid, substantially as and for the purpose described.

9. My improvements in the driving of automotors, substantially as hereinbefore described.

Dated this 27th day of February, 1905.

Marks & Clerk, 18, Southampton Buildings, London, W. C. 13, Temple Street, Birmingham, and 30, Cross Street, Manchester, Agents.

[fols. 83-88] Exhibit C-6—Omitted in printing

(Here follow side folio pages 89-93)

No. 835,262. PATENTED NOV. 6, 1906.

W. H. SODEAU.

MEANS FOR HEATING COMPRESSED GAS.

APPLICATION FILED AUG. 21, 1905.

Fig. 1.

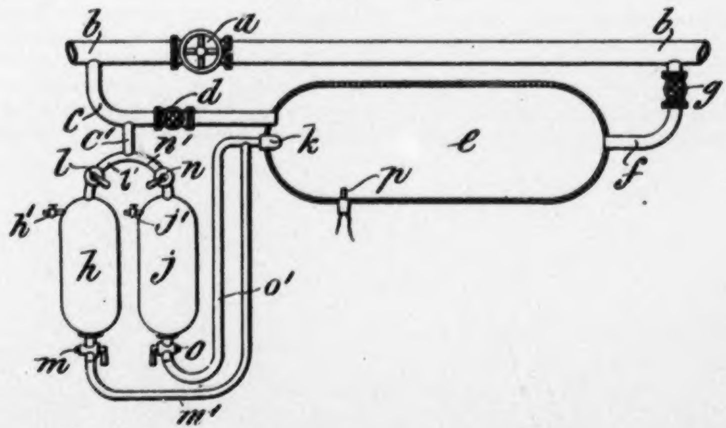
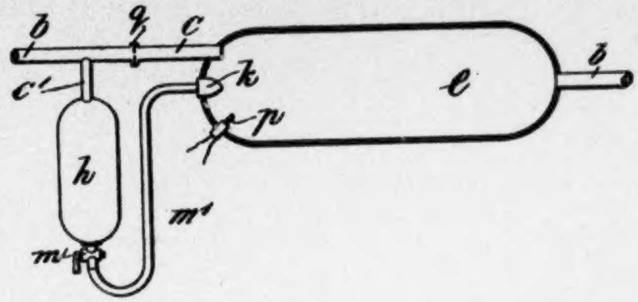


Fig. 2.

Fig. 2.



Witnesses
K H Fanning
C. J. Early

Inventor.
W. H. Sodeau
By his attorneys
Baldwin & Wight.

C-7
To Court's
findings

Pages 89-90

THE NORRIS PETERS CO., WASHINGTON, D.C.

supply pipe b and the combustion-chamber e,

P-91

UNITED STATES PATENT OFFICE.

WILLIAM HORACE SODEAU, OF NEWCASTLE-UPON-TYNE, ENGLAND, ASSIGNOR TO SIR W. G. ARMSTRONG, WHITWORTH & COMPANY LIMITED, OF NEWCASTLE-UPON-TYNE, ENGLAND.

MEANS FOR HEATING COMPRESSED GAS.

No. 835,262. Specification of Letters Patent. Patented Nov. 6, 1906.

Application filed August 21, 1905. Serial No. 275,029.

To all whom it may concern:

Be it known that I, WILLIAM HORACE SODEAU, engineering chemist, a subject of the King of Great Britain, residing at Elswick Works, Newcastle-upon-Tyne, England, have invented certain new and useful Improvements in Means for Heating Compressed Gas, of which the following is a specification.

It has before been proposed to heat compressed air or gas by means of the combustion in it of petroleum, alcohol, or other suitable combustible liquid, thereby raising the temperature of the air and consequently increasing the volume which a given weight would occupy at a given pressure. The rise of temperature has other beneficial effects, notably that it is capable of preventing the formation of ice from any water which may have been carried forward by the compressed air.

ing the size of the hole or holes in the perforated plate above described or by increasing the orifice through which the combustible liquid is discharged. The same effect is produced by decreasing the pressure, and consequently the density, of the compressed-air supply; but if the mean pressure is kept constant the proportion will be but little influenced by the rate at which the compressed air is passing, as the stream of combustible liquid will vary in practically the same degree. It will thus be seen that within reasonable limits any desired temperature can be obtained by altering the mean pressure or by changing the arrangement producing the drop in the air-pressure or by changing the fuel-delivery orifice.

When only a moderate rise of temperature is desired, as in the case of pneumatic hand-tools, &c., only a portion of the total air-sup-

of which the following is a specification.

It has before been proposed to heat compressed air or gas by means of the combustion in it of petroleum, alcohol, or other suitable combustible liquid, thereby raising the temperature of the air and consequently increasing the volume which a given weight would occupy at a given pressure. The rise of temperature has other beneficial effects, notably that it is capable of preventing the formation of ice from any water which may have been carried forward by the compressed air.

According to this invention the combustion takes place inside the pipe or passage through which the compressed air is supplied to the engine or pneumatic tool, which pipe or passage will usually be locally increased in diameter in order to provide a combustion-chamber of sufficient capacity and suitable shape, and the arrangement is such that the ratio of fuel to air can be kept practically constant or can be varied at pleasure.

The combustible liquid is contained in an appropriate vessel or fuel-reservoir communicating with the compressed-air-supply pipe at a point where the pressure is higher than in the combustion-chamber and connected to a pipe passing into the combustion-chamber, where it preferably terminates in a suitable spraying-nozzle.

In some installations there may be an already existing drop of pressure which can be utilized for feeding the combustible liquid into the combustion-chamber; but it is usually necessary to interpose a special obstacle, such as a cock or a perforated plate, in the path of the compressed air.

The amount of combustible liquid fed into the combustion-chamber per unit weight of compressed air will of course depend upon the relative densities of the two fluids and the relative resistances in the paths of each. Thus the relative proportion of a given combustible liquid may be increased by decreasing the proportion will be but little influenced by the rate at which the compressed air is passing, as the stream of combustible liquid will vary in practically the same degree. It will thus be seen that within reasonable limits any desired temperature can be obtained by altering the mean pressure or by changing the arrangement producing the drop in the air-pressure or by changing the fuel-delivery orifice.

When only a moderate rise of temperature is desired, as in the case of pneumatic hand-tools, &c., only a portion of the total air-supply need be sent through the combustion-chamber, appropriate cocks, valves, or other controlling devices being employed to obtain the desired ratio between the two air-streams which streams are, of course, subsequently reunited.

In installations which are required to run for long periods I preferably employ two or more fuel-reservoirs provided with appropriate cocks or valves so arranged that an empty reservoir may be shut off and refilled without interfering with the continuous action of the appliance. The spray may be ignited by introducing a piece of burning material into the combustion-chamber after temporarily relieving the pressure in the same (appropriate valves, cocks, doors, &c., being provided for this purpose) or while the compressed air is actually traversing the combustion-chamber by means of an ignition-tube, primer, cap, or electric ignition device.

Figure 1 is a diagrammatic sectional elevation of an apparatus suitable for use with pneumatic hand-drills and the like. Fig. 2 is is a milar view of an apparatus suitable for torpedo propulsion.

In Fig. 1 the greater part of the air passes through the cock a in the main supply-pipe b, by which it is led to the engine; but a portion takes the alternative path through the pipe c, which forms a connection between the air-supply pipe b and the combustion-chamber e,

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and becomes heated and then rejoins the main stream through the pipe f and cock g.

Liquid fuel is contained in the fuel-reservoirs h j, which are connected to the air-supply pipe b by the pipes c c' and l' and n', the pipes l' and n' being provided with cocks l and n. The reservoirs h and j are connected to the chamber e by the pipes m' and o', which are provided with cocks m and o. Fuel may be supplied to the reservoirs through the valved openings h' and j'.

The drop of pressure caused by the cock d causes the liquid fuel to be forced through the spraying-nozzle k for combustion in the chamber e.

The proportion of fuel to air in e may be increased by decreasing the opening of the cock d, while the fuller opening of the cock g or the partial closing of the cock a will cause a larger stream to pass through the chamber e. These adjustments enable the desired temperature to be obtained.

When the reservoir h becomes empty, it may be refilled after closing the cocks l and m, the supply of fuel being meanwhile obtained from the reservoir j, and the latter can be similarly filled after closing the cocks n and o. The spray may be ignited by means of an appropriate electric igniter p.

In Fig. 2 the portion of the pipe b between the pipes c and f, Fig. 1, is omitted, the pipe c being in a line with and forming a continuation of the pipe b, so that the whole of the air passes through the chamber e and is led away by the pipe f of Fig. 1, which is now merged in the outgoing portion of the pipe b. In this case the requisite head for spraying is caused by the insertion of a perforated plate q in the pipe c, through which the whole of the compressed-air stream passes into the combustion-chamber e.

When the engine has made a prearranged number of revolutions, the valve m is opened by hand and liquid fuel is forced from the reservoir h through the nozzle k into the chamber e. Almost immediately the primer p is fired and the spray is thereby ignited. In both arrangements the ends of the pipes m' and o', which are connected to the chamber e, are preferably at a higher level than the tops of the reservoirs h and j, so that fuel is only supplied to the chamber e when air is flowing through the pipe b.

What I claim is—

1. The combination of an air-supply pipe, a reservoir for liquid fuel, a combustion-chamber, connections from the pipe to the reservoir and chamber, a connection from the reservoir to the chamber, and means in the connection from the pipe to the chamber for reducing the pressure of the air-supply to the chamber as compared with that of the reservoir.

2. The combination of an air-supply pipe, a reservoir for liquid fuel, a combustion-chamber, connections from the pipe to the reservoir and chamber, a connection from the reservoir to the chamber, (the chamber end of this connection being at a higher level than the top of the reservoir,) and means in the connection from the pipe to the chamber for reducing the pressure of the air-supply to the chamber as compared with that to the reservoir.

3. The combination of an air-supply pipe, a reservoir for liquid fuel, a combustion-chamber, a connection from the pipe to the reservoir, two connections from the pipe to the chamber, a valve in the pipe between these two connections, a connection from the reservoir to the chamber, and means in one of the connections from the pipe to the chamber for reducing the pressure of the air-supply to the chamber as compared with that to the reservoir.

4. The combination of an air-supply pipe, a reservoir for liquid fuel, a combustion-chamber, a connection from the pipe to the reservoir, two connections from the pipe to the chamber, a valve in the pipe between these two connections, a connection from the reservoir to the chamber, (the chamber end of this connection being at a higher level than the top of the reservoir,) and means in one of the connections from the pipe to the chamber for reducing the pressure of the air-supply to the chamber as compared with that to the reservoir.

WILLIAM HORACE SODEAU.

Witnesses:

OSCAR FREY,

PERCY FREDERICK ALLAN.

P-92

N° 15,997 A.D. 1906

Date of Application, 14th July, 1906

Complete Specification Left, 14th Feb., 1907—Accepted, 11th July, 1907

PROVISIONAL SPECIFICATION.

Improvements relating to the Heating of Compressed Air for use in Motors.

We, SIR W. G. ARMSTRONG & COMPANY, LIMITED, Manufacturing Engineers, nd WILLIAM SODEAU, Engineer, all of Elswick Works, Newcastle-on-Tyne do ereby declare the nature of this invention to be as follows:—

This invention relates to improvements in the means used in torpedoes and the ike for heating air under high pressure within a closed chamber, such for nstance as described in our prior Patent No. 3495 of 1905.

According to the form described in our early patent mentioned above, a ombustible, preferably liquid fuel, is mixed with air under pressure from a torage vessel and the heat is used to cause the expansion and prevent undue ooling of the air which forms the working fluid in a motor, *e.g.* the propelling ngines of an automobile torpedo.

The object of the present invention is to so improve such means as to give creased safety and reliability in the firing of the fuel and air.

The invention consists in a device of the kind described in which the mixture ter being fired automatically at starting the engine is maintained burning a reliable manner by preventing undue cooling of the flame which takes place ing to the presence of an excess of air supply over that required for complete mbustion.

The invention also comprises a heating device for compressed air for use in rpedoes and the like having a fuel tank connected to the air supply and to a mbustion chamber into which the compressed air is led from a storage tank rough a reducing valve, this combustion chamber being provided with an niting device comprising a percussion primer or the like directly acted upon a piston and striker propelled forward by compressed air admitted on open- a starting valve, the air to the striker, the oil to the combustion chamber and air to the fuel tank being capable of being simultaneously shut off mechanically-connected cocks when desired.

The invention further comprises the improved arrangement of heating device use in torpedoes hereinafter described.

n carrying the invention into effect according to one form air from the age chamber in, say, a torpedo of the Whitehead type, is passed through a ting valve and a reducer into a combustion chamber where it impinges n a perforated deflecting plate. Into this combustion chamber there is also any suitable kind of liquid fuel contained in a tank subjected to an air ssure greater than that which obtains in the combustion chamber. Thus, ording to one form the air space in the fuel tank may be connected direct he reducer while any suitable construction such as a cock or perforated plate be interposed in the pipe leading from the reducer to the combustion mber. At any suitable point, as for instance in the pipe connection between starting valve and the reducer a supply pipe is led to a striker device ched to the combustion chamber. This striker device is arranged to act tly upon a percussion primer containing preferably a slow burning com- ion. A preferred construction of igniting device is as follows:—

ussion primer is placed in an appropriate holder in the outer and

of which there is screwed or otherwise held a hollow plug containing a piston. One end of this piston *viz*:—the one nearest the primer is tapered as in an ordinary percussion striker. The piston is up to the moment of firing kept at the further end of the cylinder by means of a spring, spring catch, shearing wire or any other appropriate device. The cylinder is, of course, formed in the most convenient way for extracting the primer. The air supply pipe to the striker leads into the cylinder behind the piston. In this way when the starting valve is opened air at high pressure is admitted behind the piston which is thus driven rapidly down the cylinder so that its tapered end strikes the cap of the primer and thus fires it.

In order to prevent excessive or sudden ingress of fuel to the combustion chamber which might on ignition produce an excessive increase in pressure in that chamber, the air supply pipe to the fuel tank is of constricted area while a considerable air space is provided in the fuel tank above the fuel or in a separate vessel connected therewith. In this way the accumulation of air pressure above the fuel is retarded and the starting of the fuel flow into the combustion chamber is somewhat gradual. The air pipe leading to the fuel tank and the fuel pipe leading from the fuel tank to the combustion chamber as well as the air supply pipe to the striker are all capable of being controlled by mechanically connected cocks. This control may be effected either by means of a cock or valve having three separate passages whereby on moving the cock or valve all the passages will be simultaneously controlled or one cock may be employed controlling two of the passages while another controls the third, the cocks being mechanically connected so as to rotate together. Separate cocks may be employed for each pipe.

In order that the combustion may be as complete as possible the air supply should be properly distributed to the flame around the oil nozzle leading into the combustion chamber. When, however, the air admitted to the combustion chamber is very largely in excess of that required for combustion, according to the present invention we direct a portion of the air away from the flame for instance towards the walls of the combustion chamber by means of a perforated deflecting plate while the remainder passes through the perforated screen and unites with the oil issuing through a suitable spraying nozzle.

If desired a number of perforated screens may be employed through which the air is passed before it unites with the oil issuing through the spraying nozzle. Or the air supply pipe to the combustion chamber may be provided with a suitable directing nozzle so as to cause only a portion of the air to come in contact with the flame.

Dated this 14th day of July, 1906.

MARKS & CLERK,
18, Southampton Buildings, London, W.C.
13, Temple Street, Birmingham, and
30, Cross Street, Manchester,
Agents.

COMPLETE SPECIFICATION.

"Improvements relating to the Heating of Compressed Air for use in Motors."

We, Sir W. G. Armstrong Whitworth & Company, Limited, and William Horace Sodeau, Engineers, all of Elswick Works, Newcastle-on-Tyne, in the

in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to apparatus used for increasing the energy of compressed air as used in automobile torpedoes. In such apparatus air is passed to a combustion chamber and some of it is used to support the combustion of a fuel therein, usually a liquid fuel. In some cases, *e.g.*, in our Patent No. 3495 of 1905, only some of the air is led to the combustion chamber.

The objects of the present invention are to effect increased safety reliability and efficiency in a compact air heating device.

The present invention comprises in the first place deflecting means within the combustion chamber introduced into the path of the air flowing thereto and adapted to allow only a portion of the air to pass into the region of active combustion whereas the residue is deflected away from that region preferably towards the walls of the combustion chamber where it effects a cooling of these walls.

In this manner the combustion is maintained in a reliable and efficient manner as the excess air does not cause undue cooling of the flame.

In order to still further ensure reliable and safe action we provide means for effecting a gradual admission of fuel to the combustion chamber at starting, also improved igniting and safety means, but these will be more readily understood from the accompanying drawings in which,

Figure 1 is a diagrammatic view showing the arrangement of a plant in accordance with this invention.

Figure 2 shows a modified form of air deflector:

Figures 3 and 4 illustrate one form of the safety cock arrangement which we employ, Figure 3 being a plan looking from underneath, and Figure 4 being a section on the line A B Figure 3: while

Figure 5 is a section on the line C D, of Figure 3.

In carrying this invention into effect, according to the form shown diagrammatically in Figure 1, and suitable for an automobile torpedo, air from a storage vessel, *a*, enters a starting valve, *b*, by means of a pipe, *c*, from which valve the air passes to a reducing valve, *d*, and thence into a combustion chamber, *e*, through a pipe, *f*. In the combustion chamber just opposite the inlet of the air thereto, there is provided a perforated plate, *g*, which acts as a deflector and also serves to split the air up into several streams. Further this screen assists in affecting a reduction in the air pressure which is used for feeding the fuel to the combustion chamber. From the reducing valve, *d*, there is also led a pipe, *h*, which passes through a valve or cock, *j*, hereinafter called the safety cock, and thence by a pipe, *k*, to a closed chamber, *m*, containing a liquid combustible. The liquid combustible does not entirely fill the chamber, *m*, and from the lower end of the chamber or fuel tank, *m*, there leads a pipe, *n*, to the combustion chamber, *e*, where a spraying nozzle, *o*, is provided, the safety cock, *j*, also controls the pipe, *n*.

In this device much of the air entering the combustion chamber is deflected by the deflector so as to pass down by the sides of the combustion chamber in an annular stream, while a portion of the air passes through the perforations in the deflector plate and supports the combustion of the liquid fuel issuing from the nozzle. By this means the walls of the combustion chamber are kept comparatively cool, while no objectionable excess of air is supplied in the neighbourhood of the ignited liquid fuel, and the flame is thus maintained at a sufficiently high temperature. The fuel supply to the combustion chamber will also be retarded during a short period after the admission of air to the engine on account of the air space provided in the fuel tank. The purpose of this will be more clearly understood hereafter.

The ignition of the fuel issuing from the nozzle, *o*, is effected by means of a

priate holder, *p*, in the outer end of which there is screwed or otherwise held a hollow plug or cylinder, *r*, containing a piston, *q*. One end, *s*, of this piston, *viz*., the one nearest the primer, 6, may be tapered as in an ordinary percussion striker. The piston is, up to the moment of firing, kept at the further end of the cylinder, *r*, by means of a spring or a spring catch, shearing wire or any other appropriate device may be used. The cylinder is formed in the most convenient way for extracting the primer when it is desired to do so. In the form shown the cylinder, *r*, within the case, *p*, is perforated by holes, 7, at its upper end, through which holes the compressed air from the pipe, *t*, passes. A stop 8, is screwed into the end of the cylinder, *r*, and an outside cover, 9, is screwed over all. In this way by unscrewing the cover, 9, and withdrawing the cylinder, *r*, the primer, 6, may be readily changed.

The air supply passage, *t*, to the striker leads into the cylinder, *r*, behind the piston, *q*. In this way when the starting valve, *b*, is opened compressed air is admitted behind the piston which is thus driven rapidly downwards against the action of the spring, *z*, so that its tapered end strikes the cap of the primer and thus fires it.

Instead of causing the striker to move against a stationary primer the striking pin may be made stationary and the primer arranged to slide.

In order to prevent excessive or sudden ingress of fuel to the combustion chamber, *e*, which might on ignition produce an excessive increase in pressure, in that chamber, the air supply pipe to the fuel tank is of limited area, while a considerable air space is provided in the fuel tank above the fuel or in a separate vessel connected therewith. In this way the accumulation of air pressure above the fuel is retarded and the starting of the fuel flow into the combustion chamber is somewhat gradual.

The safety cock, *j*, Figures 3, 4 and 5, is composed in the form illustrated of two plugs, *u* and *v*, having levers 2 and 3 fixed thereto, said levers being articulated together by links, so that both barrels are moved simultaneously, any other method of articulation may be adopted, however, so long as the three passages, *h*, *n* and *t*, or any two of them are simultaneously controlled. On opening the starting valve it will be seen that no combustion will occur in the chamber, *e*, unless the safety cock, *j*, is opened, and it is impossible to start the fuel supply to the combustion chamber without simultaneously starting the igniter, and in all cases a proper interval occurs between the firing of the igniter and the gradual admission of fuel to the combustion chamber.

During the time in which the safety cock is closed the torpedo may be manipulated in a similar way to those torpedoes working without air heating which manipulation would otherwise cause the firing of the primer and cause fuel to gain access to the combustion chamber.

Instead of a single deflecting plate, *q*, a number of such plates may be employed, or a deflecting nozzle, 4, as shown in Figure 2, may be used. The deflecting nozzle, 4, is so shaped that only a portion of the air is directed towards the burning fuel. In the form shown the holes at the end of the nozzle direct jets of air towards the jet of liquid combustible while the side holes direct the air jet against the walls of the combustion chamber and away from the fuel jet.

It is found in actual practice that the pipes conveying the air and fuel may sometimes give sufficient retardation of fuel without the employment of a special air space in the fuel flask. The air for the striker may be taken from the combustion chamber, engine pipe or fuel flask as alternatives.

The safety cock is sometimes employed to close merely the two passages controlling the fuel supply, in order to save weight and complication.

Many modifications may be made to the details of the apparatus hereinbefore described. Thus the safety cock may be arranged in one barrel, or in two or three; the form of primer may be altered, and the specific means for deflecting

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed we declare that what we claim is:—

1. In an air heating device for use in automobile torpedoes in which air is passed through a combustion chamber and a portion of it burned with fuel in said combustion chamber, means within the combustion chamber and opposite the air inlet thereto for deflecting the surplus air away from the region of the flame and directing the air for combustion towards said region, substantially as and for the purpose described.

2. In an air heating device for automobile torpedoes employing a separate combustion chamber, a deflector such as *g*, over the air inlet to said combustion chamber, substantially as and for the purposes described.

3. In an air heating device of the type herein described for automobile torpedoes and the like, a percussion ignition device having in combination with a fluid operated striker piston and primer, a removable cylindrical liner and cover holding said liner and primer in place, substantially as and for the purpose hereinbefore described with reference to the accompanying drawings.

4. In an air heating device of the type described a safety cock simultaneously controlling any two or all of the following (*a*) the supply of compressed air to the striker, (*b*) the supply of compressed air to the fuel tank, and (*c*) the fuel supply to the combustion chamber, substantially as described.

5. An air heating device for use in automobile torpedoes and the like having the parts arranged and co-operating, substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 14th day of February, 1907.

MARKS & CLERK,
18, Southampton Buildings, London, W.C.
13, Temple Street, Birmingham, and
30, Cross Street, Manchester,
Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1907.

[This Drawing is a full-size reproduction of the Original.]

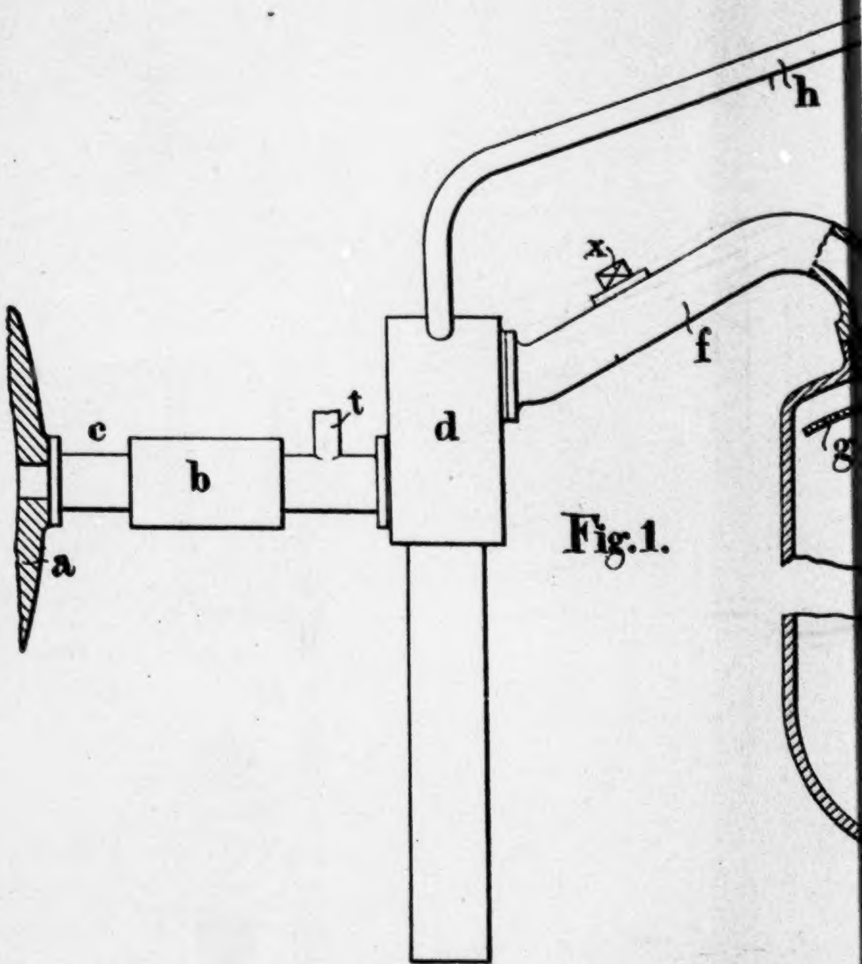

Fig.1.

[This Drawing is a full-size reproduction of the Original.]

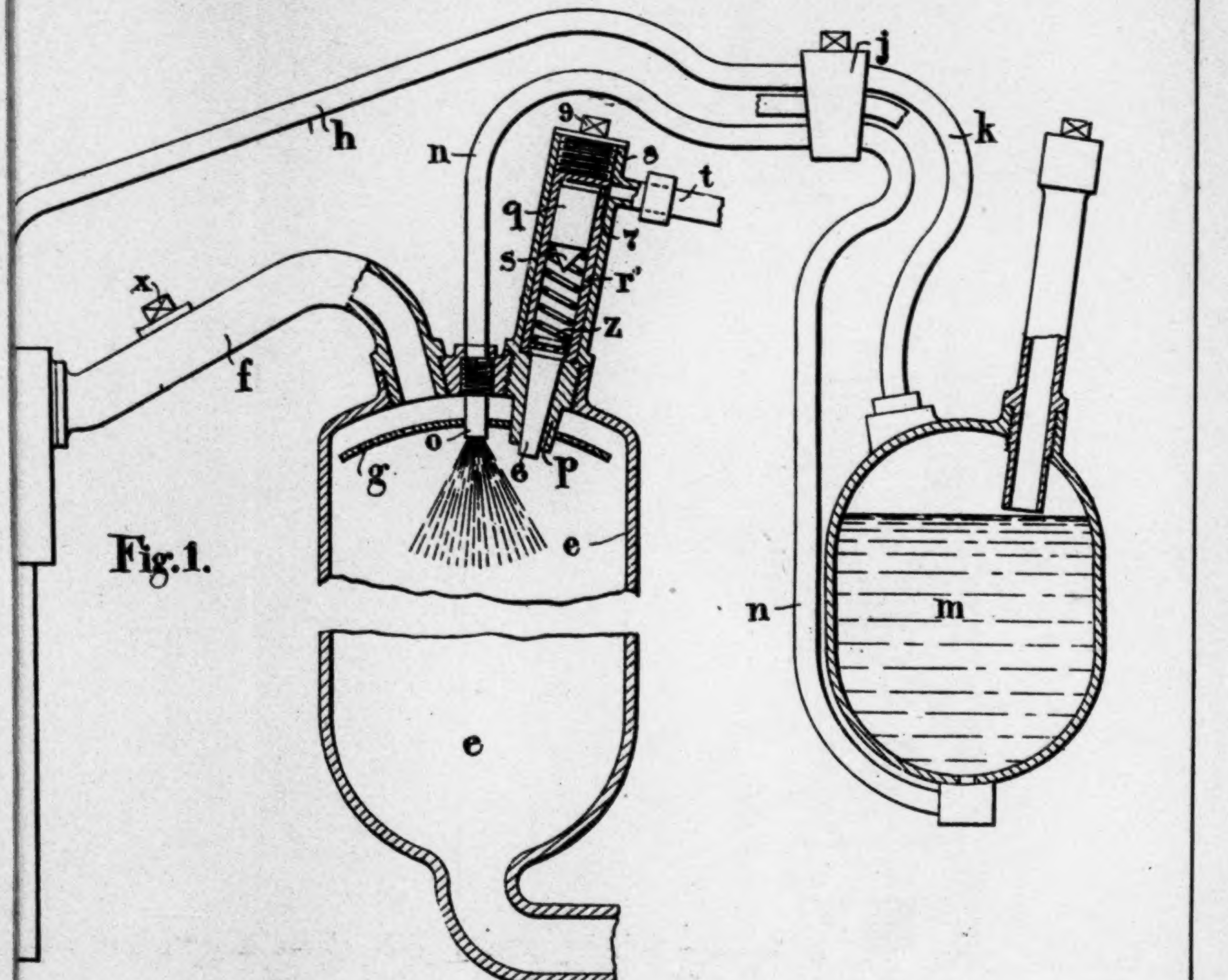

Fig. 1.

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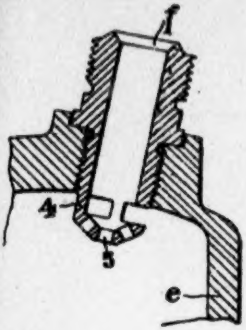

Fig. 2.

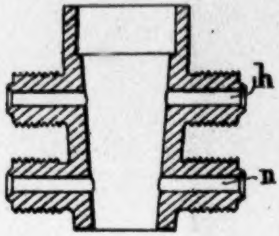

Fig. 5.

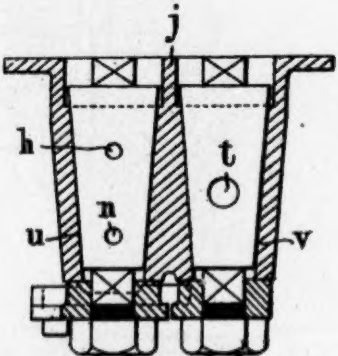

Fig. 4

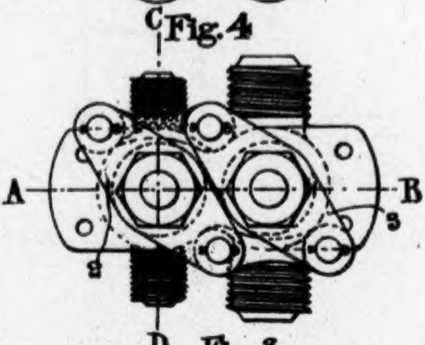

Fig. 3.

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SIR G. ARMSTRONG, WHITWORTH & CO. & *another's* COMPLETE SPECIFICATION.

P – 104

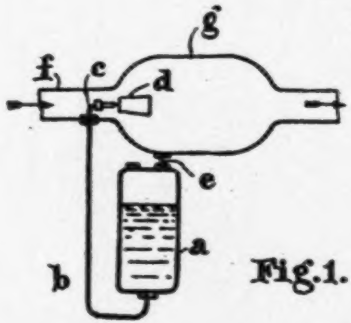

Fig.1.

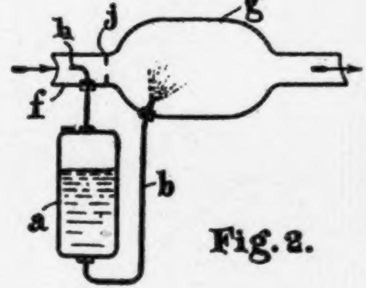

Fig. 2.

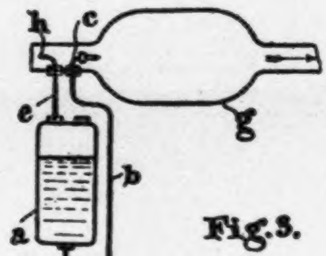

Fig.3.

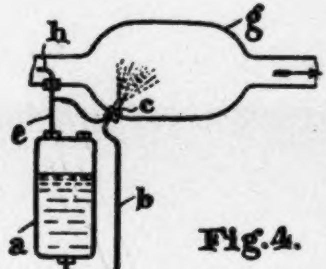

Fig.4.

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[This Drawing is a reproduction of the Original on a reduced scale

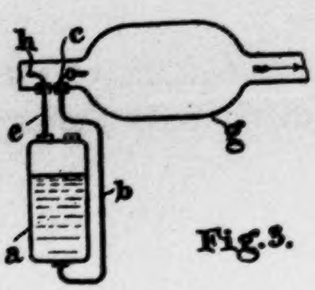


Fig.3.

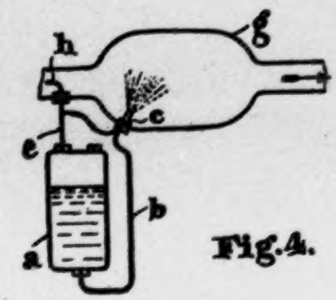


Fig.4.

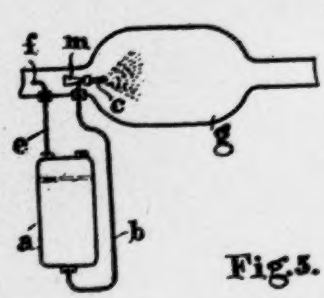


Fig.5.

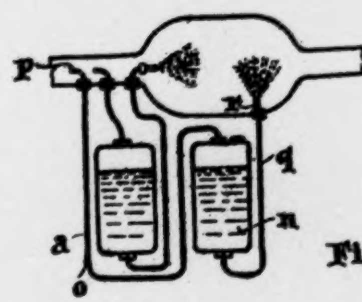


Fig.6.

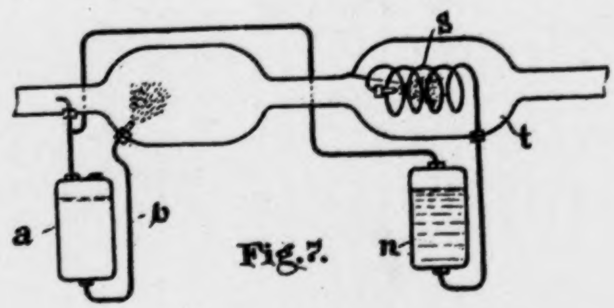
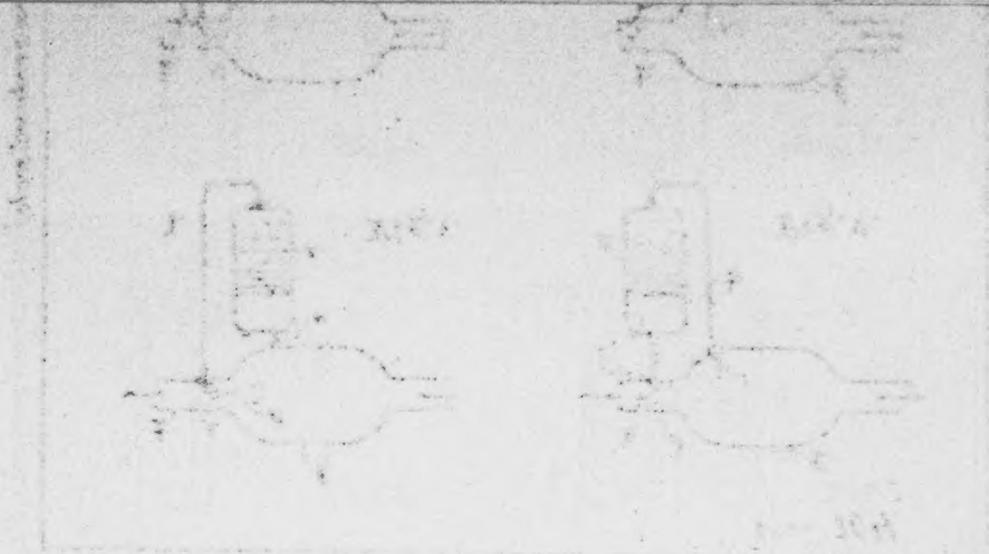


Fig.7.



[fols. 97–103] Exhibit C-9—Omitted in printing

(Here follows side folio page 104)

[Matter apparently omitted here.—Printer.]

[fol. 105] centrally at the entrance to the combustion chamber; the air space at the top of the fuel tank may be connected to the combustion chamber itself or by means of a Pitot tube to the air conduit and in addition a scent-spray action may be obtained by providing a cone collector facing towards the stream, this cone collector being arranged to conduct air to the oil spraying nozzle.

Where required, the Pitot action may be assisted by providing a suitable resistance in the pipe such as described in our Patent No. 3495, 1905.

All the above arrangements may also be applied in the case of those forms of heating devices in which water or other appropriate liquid is injected into the products of combustion either directly as a spray or indirectly through a coil or chamber exposed to the heated products of combustion, for the purpose of simultaneously increasing the volume of motive fluid supplied to the engine and reducing the temperature of that motive fluid to a workable amount.

Dated this 12th day of March, 1907.

Marks & Clerk, 18, Southampton Buildings, London, W. C., 13, Temple Street, Birmingham, and 30, Cross Street, Manchester, Agents.

Complete Specification

"Improvements in and relating to Means for Increasing the Energy of Stored Compressed Air"

We, Sir W. G. Armstrong, Whitworth and Company, Limited, and Dr. William Horace Sodeau, all of Elswick Works, Newcastle-on-Tyne, in the County of Northumberland; Engineers; do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention relates to heating apparatus such as used in compressed air plant for heating the air before passing the same to a motor. In such plant it is known to increase the energy of the compressed air by burning therein a liquid fuel. The present in-

vention has particular reference to the means used for feeding the fuel to the combustion chamber, and if so desired water or the like vaporisable liquid into the combustion products for the purpose of reducing the temperature of the same, and at the same time adding to the quantity of working fluid led to the engine.

The object of the present invention is to improve and simplify apparatus of this kind so as to give a simple and automatic adjustment of the fuel, water or like feed in accordance with the density of the air flowing through the combustion chamber or the like and proportional to the quantity or rate of flow of such air.

The present invention consists in means for increasing the energy of stored compressed air comprising means for feeding fuel, water or the like into the compressed air, said feeding means being dependent on the kinetic energy of the air passing any cross section of the pipe leading from the reservoir to the engine.

The means used for feeding comprise a Pitot tube or the like set in the path of the air flowing to the engine either a direct or reverse Pitot action may be employed as in either case the feeding action will be dependent on the kinetic energy of the air stream that is dependent on the square of the velocity of flow and on the density. In-[fol. 106] stead of or in addition to the Pitot tube an ordinary injector action may be employed.

Referring now to the accompanying diagrammatic drawings which show convenient constructions of this invention such as may be applied to the air heating devices used in automobile torpedoes:

Figures 1 to 5 illustrate diagrammatically means the feeding liquid fuel only into the combustion chamber;

Figures 6 and 7 show means for feeding both liquid fuel and water or the like into the air and combustion products respectively.

According to Figure 1, liquid fuel from a tank, a, is led by a pipe, b, to a nozzle, c, within the air conduit pipe, f. The nozzle, c, points in the direction of flow of the air and into an open cone piece, d. A pipe, e, leads from the combustion chamber, g, which is conveniently an enlargement of the air conduit pipe, to the upper end of the fuel tank, a. The air passing through the pipe, f, to the combustion chamber, g, exerts a suction or injection action on the fuel. This suction action is of course proportional to the kinetic energy of the moving stream.

In Figure 2 instead of employing an injector cone, d, we employ a "Pitot" tube, h, set to face the stream of air passing into the combustion chamber, g. In this way, as is well known, a greater pressure than that in the pipe, f, is transmitted to the fuel tank, a, and the difference of the pressures in the pipe, f, and tank, a, in this form is dependent on the kinetic energy of the stream. In many cases it may be found desirable to place some resistance such as a perforated plate, j, in the pipe, f, between the Pitot tube, h, and the combustion chamber, g, as the "Pitot" pressure difference may not be sufficient to effect satisfactorily the feeding. This resistance may however be of any convenient form and in fact the pipe leading to the combustion chamber may be arranged itself to offer a sufficient

resistance for the purpose required. The fuel in the form shown in Figure 3 is led to a spraying nozzle in the combustion chamber.

In Figure 3 the Pitot tube action is employed for collecting the air pressure on the liquid fuel while a reverse Pitot tube is employed for spraying. In this way the Pitot action is increased and in some cases no additional resistance may be required.

In Figure 4 a Pitot tube is employed for collecting the pressure on the top of the liquid fuel and also for collecting air of slightly higher pressure than that in the combustion chamber for the purpose of spraying fuel which is led from the oil tank, a, to the nozzle, c.

In Figure 5 instead of taking the spraying air from the Pitot tube, there is provided a cone, m, which collects the air and helps the oil to spray from the nozzle, c.

In Figure 6 the form of fuel feed illustrated in Figure 3 is employed and in addition to the fuel tank there is provided a reservoir, n, for water, a solution of ammonia salts or the like. The tank, n, is connected by a pipe, o, to a Pitot tube, p, and by a pipe, q, to a nozzle, r, in the combustion chamber, whereby water or the like is sprayed into the products of combustion which not only has the effect of cooling these down to a workable point but also adds to the volume of working fluid passed to the engine. In torpedoes where space is somewhat limited this is a point of considerable importance.

In Figure 7 instead of leading the water or the like from the tank, n, directly into the combustion products it is first led through a spiral, s, placed conveniently in an enlarged portion, t, of the pipe leading from the combustion chamber to the engine. The water or the like is heated while passing through the spiral and is discharged into the combustion products, as indicated at, t, in the form of a vapour or hot liquid.

The feeding of water or the like may of course be aided by means of a resistance in the path of the main air steam as in the case of feeding fuel.

It will be evident that there are many equivalent ways of directly [fols. 107 & 108] using the kinetic energy of the stream flowing to the engine to feed the liquid fuel water or the like into the air or combustion products.

We are aware that proposals have been made to feed fuel or water from a reservoir into a pipe by static pressure; for instance it has been proposed to connect the air space of a water reservoir with an air pipe in front of a reducing valve in the air pipe, and to connect the water space of the reservoir with the air pipe behind the reducing valve, at a point where the pressure is reduced, this latter connection being made by a pipe which enters the casing of the reducing valve and extends a short distance coaxially within the air pipe in the direction of flow of the air therein. The liquid is forced from the reservoir into the air pipe by the difference of pressure which exists between the two sides of the reducing valve. We make no claim however to such arrangements but:

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:

1. In a heating device for stored compressed air, means depending upon the kinetic energy of the air passing a given section of pipe leading said air to the engine for feeding fuel, water or the like into the air or combustion products, substantially as described.

2. In a heating device for stored compressed air for use in a motor, means for feeding fuel, water or the like into the air or combustion products comprising a closed oil tank connected by a tube to a Pitot tube or the like, placed in the current flowing to the motor, substantially as described.

3. Improved means for feeding liquid fuel into compressed air flowing through a combustion chamber or water or the like into combustion products flowing from said combustion chamber, substantially as described and illustrated in the accompanying diagrammatic drawings.

Dated this 14th day of October, 1907.

Marks & Clerk, 18, Southampton Buildings, Chancery Lane, London, W. C., 13, Temple St., Birmingham, and 30, Cross St., Manchester.

(Here follow side folio pages 109-115)

[fol. 116] No. 18,241, A. D. 1908

Date of Application, 31st Aug., 1908—Accepted, 25th Feb., 1909

Complete Specification

Improvements in Apparatus for Increasing the Working Efficiency of Compressed Air and Gas Motor Plants

I, Johann Gesztesy, of Pola, Austria, Imperial and Royal Lineship Lieutenant, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:

Methods of and apparatus for increasing the working capacity of compressed air motors, particularly those employed for automobile torpedoes, have already been described in which the compressed air (its pressure being maintained meanwhile), is mixed with a finely divided liquid fuel and the latter ignited in a special heating chamber, in which a continuous combustion takes place during the working of the motor by the fall of pressure produced thereby. In this method of working the actual quantity of fuel burnt is accurately limited by the introduction of a definite quantity of fuel, below the original pressure of the compressed air, after which the gases of combustion are mixed with steam, which is produced by the introduction

W. H. SODEAU.

MEANS FOR INCREASING THE ENERGY OF STORED COMPRESSED AIR.

APPLICATION FILED JAN. 27, 1908.

964,574. **Patented July 19, 1910.**

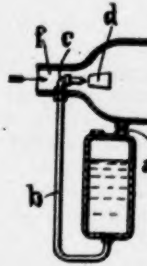


Fig. 1.

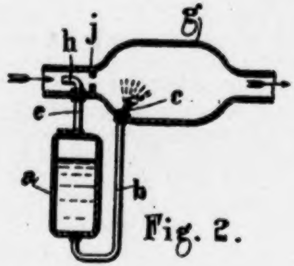


Fig. 2.

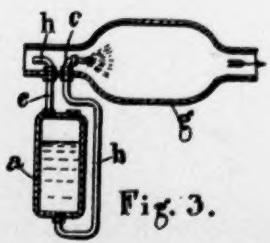


Fig. 3.

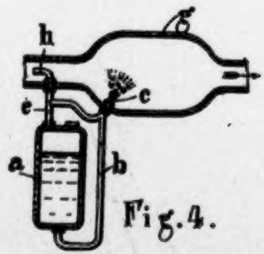


Fig. 4.

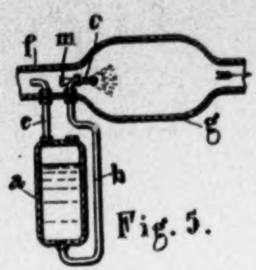


Fig. 5.

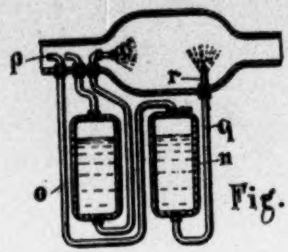


Fig. 6.

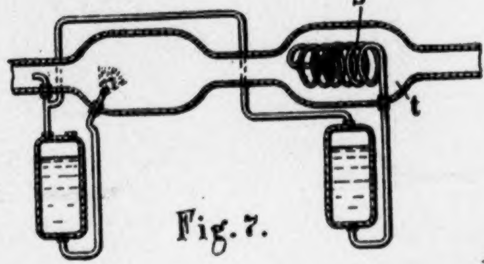


Fig. 7.

ATTEST.
Bent M. Stahl.
Ewd L. Tolson.

INVENTOR.
WILLIAM H. SODEAU
BY Spear Middleton Donaldson & Spear
ATTY'S

C-11
To Court's findings
Pages 109-110

UNITED STATES PATENT OFFICE.

WILLIAM HORACE SODEAU, OF NEWCASTLE-UPON-TYNE, ENGLAND, ASSIGNOR TO SIR W. G. ARMSTRONG WHITWORTH & COMPANY, LIMITED, OF NEWCASTLE-UPON-TYNE, ENGLAND.

MEANS FOR INCREASING THE ENERGY OF STORED COMPRESSED AIR.

964,574. Specification of Letters Patent. **Patented July 19, 1910.**

Application filed January 27, 1908. Serial No. 412,921.

To all whom it may concern:

Be it known that I, William Horace Sodeau, a subject of the King of Great Britain and Ireland, residing at Elswick Works, Newcastle-upon-Tyne, in the county of Northumberland, England, have invented certain new and useful Improvements in Means for Feeding Liquids into Combustion-Chambers, of which the following is a specification.

This invention relates to apparatus such as is used in connection with plant using compressed air for operating a motor or the like. In such plant it is known to increase the energy of the compressed air by burning therein a liquid fuel.

The present invention has particular reference to the means used for feeding the fuel to the combustion chamber, and if so desired water or the like vaporizable liquid into the combustion products for the purpose of reducing the temperature of the same, and at the same time adding to the quantity of working fluid led to the engine.

The object of the present invention is to improve and simplify apparatus of this kind so as to give a simple and automatic adjustment of the fuel, water or like feed in accordance with the density of the air flowing through the combustion chamber or the like and proportional to the quantity or rate of flow of such air.

The present invention consists in means for increasing the energy of stored compressed air comprising means for feeding fuel, water or the like into the compressed air, said means being dependent on the kinetic energy of the air in the pipe leading from the reservoir to the engine.

The means used for feeding comprise a Pitot tube or the like set in the path of the air flowing to the engine—either a direct or reverse Pitot action may be employed as in either case the feeding action will be dependent on the kinetic energy of the air stream that is dependent on the square of the velocity of flow and on the density. Instead of or in addition to the Pitot tube an ordinary injector action may be employed.

Referring now to the accompanying diagrammatic drawings which show convenient constructions of this invention such as may be applied to the air heating devices used in automobile torpedoes; Figures 1 to 5 illustrate diagrammatically means for feeding liquid fuel only into the combustion chamber; Figs. 6 and 7 show means for feeding both liquid fuel and water or the like into the air and combustion products respectively.

According to Fig. 1, liquid fuel from a tank, *a*, is led by a pipe, *b*, to a nozzle, *c*, within the air conduit pipe, *f*. The nozzle, *c*, points in the direction of flow of the air and into an open cone piece, *d*. A pipe, *e*, leads from the combustion chamber, *g*, which is conveniently an enlargement of the air conduit pipe to the upper end of the fuel tank, *a*. The air passing through the pipe, *f*, to the combustion chamber, *g*, exerts a suction or injection action on the fuel. This suction action is of course proportional to the kinetic energy of the moving stream.

In Fig. 2 instead of employing an injector cone, *d*, a "Pitot" tube, *h*, is employed to set to face the stream of air passing into the combustion chamber, *g*. In this way, as is well known, a greater pressure than that in the pipe, *f*, is transmitted to the fuel tank, *a*, and the difference of the pressures in the pipe, *f*, and tank, *a*, in this form is dependent on the kinetic energy of the stream. In many cases it may be found desirable to place some resistance such as a perforated plate, *j*, in the pipe, *f*, between the Pitot tube, *h*, and the combustion chamber, *g*, as the "Pitot" pressure difference may not be sufficient to effect satisfactorily the feeding. This resistance may however be of any convenient form and in fact the pipe leading to the combustion chamber may be arranged to itself offer a sufficient resistance for the purpose required. The fuel in the form shown in Fig. 3 is led to a spraying nozzle in the combustion chamber.

In Fig. 3 the Pitot tube action is employed for collecting the air pressure on the liquid fuel while a reverse Pitot tube is employed for spraying. In this way the Pitot action is increased and in some cases no additional resistance may be required.

In Fig. 4 a Pitot tube is employed for collecting the pressure on the top of the liquid fuel and also for collecting air of slightly higher pressure than that in the combustion chamber for the purpose of spraying fuel which is led from the oil tank, *a*, to the nozzle, *c*.

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In Fig. 5 instead of taking the spraying air from the Pitot tube, there is provided a cone, *m*, which collects the air and helps the oil to spray from the nozzle, *c*.

In Fig. 6 the form of fuel feed illustrated in Fig. 3 is employed and in addition to the fuel tank there is provided a reservoir, *n*, for water, a solution of ammonia, salts or the like. The tank, *n*, is connected by a pipe, *o*, to a Pitot tube, *p*, and by a pipe, *q*, to a nozzle, *r*, in the combustion chamber, whereby water or the like is sprayed into the products of combustion which not only has the effect of cooling these down to a workable point but also adds to the volume of working fluid passed to the engine. In torpedoes where space is somewhat limited this is a point of considerable importance.

In Fig. 7 instead of leading the water or the like from the tank, *n*, directly into the combustion products it is first led through a spiral, *s*, placed conveniently in an enlarged portion, *t*, of the pipe leading from the combustion chamber to the engine. The water or the like is heated while passing through the spiral and is discharged into the combustion products as indicated at *t*, in the form of a vapor or hot liquid.

The feeding of water or the like may of course be aided by means of a resistance in the path of the main air stream as in the case of feeding fuel.

It will be evident that there are many equivalent ways of directly using the kinetic energy of the stream flowing to the engine to feed the liquid fuel water or the like into the air or combustion products.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. Means for increasing the energy of stored compressed air comprising in combination a combustion chamber, a conduit leading compressed air to said combustion chamber, a receptacle for liquid, means leading from said receptacle to said combustion chamber and means connecting said receptacle with the compressed air conduit, said means having an opening in the conduit facing toward the oncoming air whereby the kinetic energy of the air stream in the conduit produces a pressure in the liquid receptacle in excess of that in the air conduit and combustion chamber.

2. Means for increasing the energy of stored compressed air, comprising in combination a combustion chamber, a receptacle for liquid fuel, a jet in said combustion chamber, a pipe leading from said receptacle to said jet, a Pitot tube placed in a passage in which a current of air is flowing, and a pipe leading from said receptacle to said Pitot tube, as and for the purpose described.

3. Means for increasing the energy of stored compressed air comprising in combination a combustion chamber, a passage through which air or gases are flowing, a water receptacle, a pipe connecting between the bottom of said water receptacle and the end of said chamber remote from said air passage, a Pitot tube in said passage and a connection from said Pitot tube to said water receptacle, as and for the purposes described.

4. Means for increasing the energy of stored compressed air comprising in combination a combustion chamber, a conduit leading compressed air to said combustion chamber, a fuel receptacle, means leading from said receptacle to said combustion chamber, and means connecting said receptacle with the compressed air conduit, said means having an opening in the conduit facing toward the oncoming air whereby the kinetic energy of the air stream in the conduit produces a pressure in the fuel receptacle in excess of that in the air conduit and combustion chamber, and a water receptacle, means leading from said water container to the combustion chamber, and means connecting said water container with the compressed air conduit, said means having an opening in the conduit facing toward the oncoming air whereby the kinetic energy of the air stream in the conduit produces a pressure in the water container in excess of that in the air conduit and combustion chamber.

5. Means for increasing the energy of stored compressed air comprising a combustion chamber, a liquid reservoir, a conduit leading air to said combustion chamber and means acting to utilize the kinetic energy of the air stream entering the combustion chamber to produce a greater pressure in said receptacle than exists in said air conduit and means for delivering liquid from the receptacle into the combustion chamber.

6. Means for increasing the energy of stored compressed air, comprising in combination a combustion chamber, a fuel receptacle, a water receptacle, connections from said fuel and water receptacles respectively to said chamber, a passage through which air or gases are flowing, Pitot tubes in said passage, and connections between said Pitot tube and said receptacles.

In testimony whereof, I affix my signature in presence of two witnesses.

WILLIAM HORACE SODEAU.

Witnesses:

STEPHEN MAGUIRE MURRAY,
ROBERT WALLS THOWBURN.

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A.D. 1908 Aug. 31 N° 18,241.
GESZTESY'S COMPLETE SPECIFICATION.

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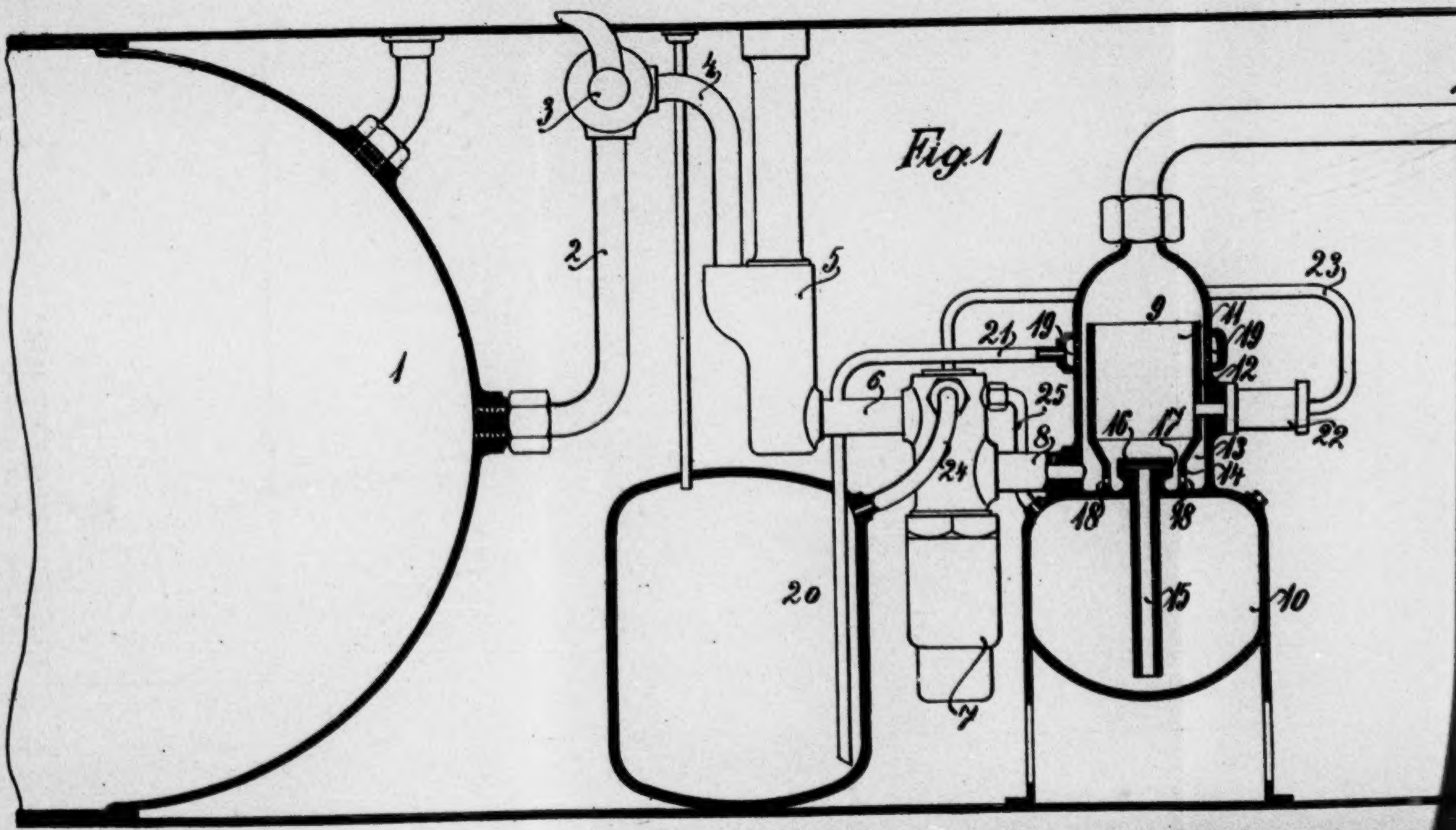

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Fig. 2

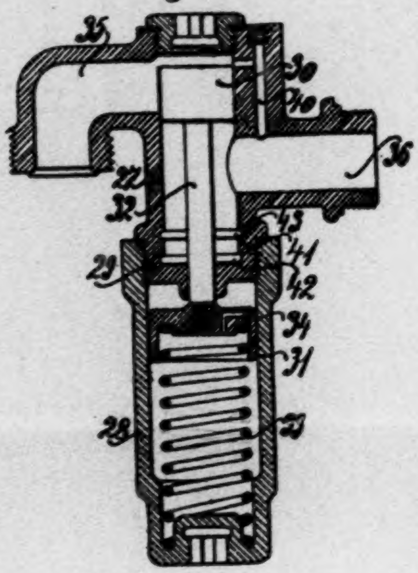


Fig. 4

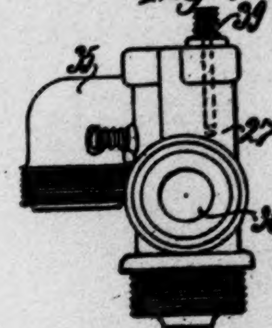


Fig. 5
Schnitt x x.

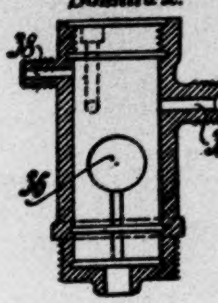
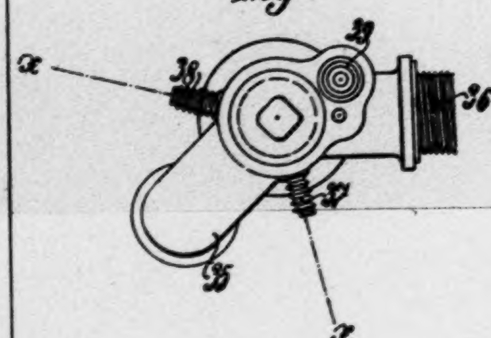


Fig. 3



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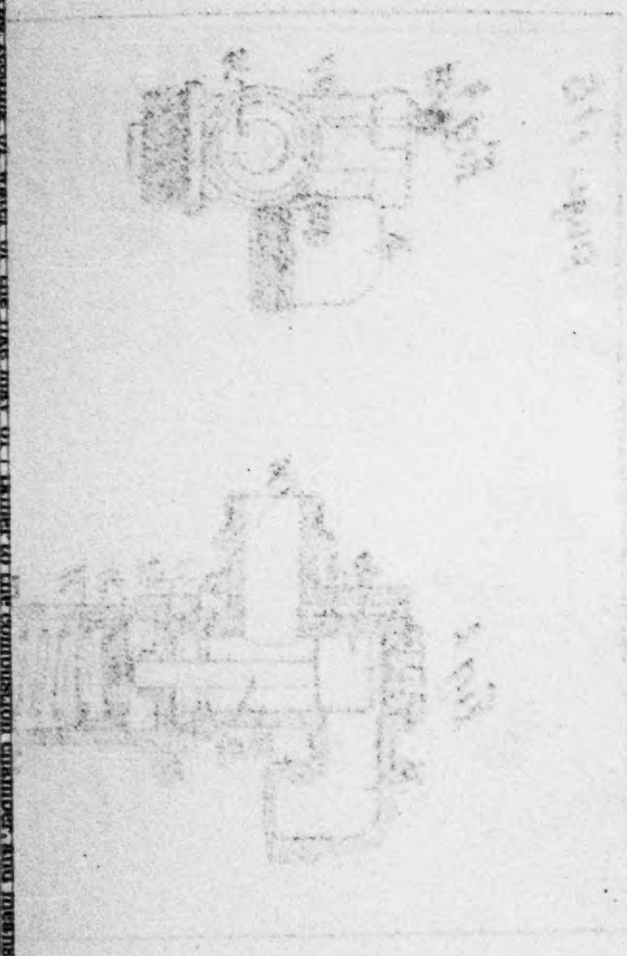

of water into the heating chamber and this high pressure mixture reduced down to working pressure.

It has also been heretofore proposed to arrange automatic pressure retarding apparatus between the compressed air reservoir and the motor, the characteristic feature of such apparatus being that in a casing connected to the compressed air pipe there are placed two movable pistons which are connected with each other and acted upon by spring pressure and of which the larger one acts as a brake piston, while the smaller one comprises a cylindrical portion adapted to close the opening for the passage of the air and a conical portion which projects upwardly into the compressed air entrance chamber This conical portion is pressed down onto its seat by the spring and also by the compressed air, which fills the whole of the compressed air pipe when the compressed air is admitted to the apparatus, while, as soon as the pressure of the air in the pipe leading to the motor falls, owing to the starting of the motor, the piston is shifted against the action of the spring and the brake piston, by the compressed air acting upon its other side so that after its cylindrical portion has completely emerged from the passage opening the conical portion opens the way for the passage of the air to a greater or less extent according to its position.

Now the object of this invention is to provide an improved or more perfect construction of apparatus of this type.

In a complete torpedo plant embodying the improved apparatus the working is as follows:

1. The pressure in the compressed air heating apparatus is reduced to such an extent at the commencement, after starting the motor, that the rise of pressure effected by the first ignition of the charging mixture is never such as to exert any injurious effect on the motor.

2. The pressure after ignition has been effected is gradually raised so that the motor is gradually started in a way that obviates injuriously effecting it.

3. The relative times of the commencement of the supply of fuel and water, as well as of the actuation of the igniting device are so regulated that they follow each other in such order as to ensure satisfactory working.

4. Finally, should the torpedo accidentally turn over during the [fol. 116½] preliminary manipulation therewith, the improved apparatus prevents the fuel or the water from running out of the corresponding reservoirs into the pipe or into the heating apparatus and so into the engine.

All these conditions in working can be attained in a simple way by a pressure retarding device constructed as regards its essential features substantially as the one before indicated, as heretofore proposed, but the improved apparatus constructed according to this invention is also adapted to at the same time suitably control the supply of air, fuel and water.

Fig. 1 of the accompanying illustrative drawings is a general representation of a compressed air motor plant for a torpedo.

Figs. 2, 3, 4 and 5 show the pressure retarding and controlling apparatus in vertical longitudinal section, plan, part side elevation and vertical section corresponding to the line x—x of Fig. 3, respectively.

1 is the compressed air reservoir from which a pipe 2 leads to the starting valve 3 that is connected by a pipe 4 to the pressure regulator 5.

A pipe 6 places the pressure regulator 5 in communication with the pressure retarding and controlling apparatus 7, from which the compressed air passes through a union 8 into the heating apparatus 9.

The heating apparatus 9 and the fuel supplying and igniting apparatus may be constructed as described in the Specification of Letters Patent No. 7390 of 1906, that is to say it comprises a casing mounted upon the fuel reservoir 10 and in which a vessel 11 surrounding the combustion chamber and open at the top is so placed that an annular space 12 is left all round it between it and the wall of the chamber. This vessel 11, which, for the purpose of intimately mixing the fuel with the compressed air may be provided with a perforated partition, tapers at the bottom into a cylindrical portion 14 of reduced diameter surrounded by an enlarged annular space 13 and mounted upon the fuel reservoir 10, and projecting upwardly into this portion 14 is an ascension pipe 15 that depends nearly to the bottom of the fuel reservoir 10 and the upper end of which carries a cylindrical head 16 formed with radial holes 17. The head 16 extends nearly to the wall of the surrounding portion 14 and in a way divides the vessel 11 into two parts connected by the narrow annular space around the head 16. The lower part of the vessel 11 communicates by holes 18 with the annular space 13 into which the union 8 opens. Upon the outside of the casing of the heating apparatus is an annular passage 19 which communicates by a pipe 21 with the water reservoir 20 and by small holes in the casing with the annular space 12 surrounding the vessel 11.

22 is the ignition device to be set in operation by the compressed air and which by means of the pipe 23 communicates with a pressure retarding apparatus and controlling device 7 constructed according to this invention. This apparatus 7 also communicates by means of a pipe 24 with the water reservoir 20 and by means of a pipe 25 with the fuel reservoir.

26 is a pipe leading to the motor.

If the fuel reservoir 10 be charged with fuel and the starting valve 3 be opened compressed air will flow through the pipes 2 and 4, through the pressure regulator 5 and through the pressure retarding device and controlling apparatus 7 (to be hereinafter described) into the heating apparatus where it fills the chambers thereof. It passes also through the pipe 25 into the fuel reservoir 10 and drives fuel through the ascension pipe 15 and upwardly through the radial perforations 17 in the body 16 where it mixes with the compressed air and is ignited by the ignition apparatus 22 which is likewise set in action by the compressed air through the pipe 23. Water is simul-

taneously forced out of the reservoir 20 through the pipe 21 into the annular passage 19, thence through the holes in the casing of the heating apparatus into the annular passage 12, where it is broken up into a fine state of subdivision by the compressed air flowing through, and mixed therewith. In the upper part of the heating apparatus this mixture meets with the outgoing hot gases of combus- [fol. 117] tion with which it mixes, the atomised water being simultaneously converted into steam, and the mixture which finally results is supplied to the motor for the performance of work.

In order to regulate the method of working herein described, particularly when starting the motor, the improved pressure retarding apparatus and controlling device 7, shown to a larger scale in Figs. 2, 3, 4 and 5 is constructed as follows:

The apparatus comprises two superposed cylindrical casings 27 and 28, which are separated from each other by a partition 29 formed with a central hole. In each of the two casings 27 and 28 is inserted a somewhat tightly fitting piston 30 and 31 respectively, which are connected to each other, either rigidly or flexibly, by a piston rod 32 which passes through the central hole in the partition 29. Underneath the lower piston 31 is placed a powerful helical spring 33 by the force of which both pistons are constantly forced upwardly. The space below the piston 31 is also filled with a fluid that retards downward movement of such piston which is formed with a small passage 34 through which the fluid is forced on the downward movement of the piston.

The upper casing 27 is provided with two large branches 35 and 36 and three small branches 37, 38 and 39 which open into the interior of the casing. The branch 35 serves for the admission of air and is therefore connected to the pipe 6, see Fig 1. The branch 36 which is at a slightly lower level serves for the outlet of air to the heating apparatus and is therefore connected to the pipe 8, see Fig. 1. Between these two branches 35 and 36 are placed at definite heights the three smaller branches 37, 38 and 39 which serve for the pipe connections to the fuel reservoir, the water reservoir and the ignition device respectively.

These three branches are so arranged that the openings therefrom leading into the casing 27 are completely shut off by the upper piston 30 when this piston is in its highest position, in which position however a small space remains between it and the upper end of the casing 27 and from this space above the piston a narrow passage 40 formed through the wall of the casing leads to the lower branch 36, so that even when the piston is in this position a portion of the compressed air can pass over from the branch 35 to the union 36.

When the apparatus is not in action the piston 30 effectually closes the two connecting pipes 8 and 24 to the fuel and water reservoirs so that when the torpedo is turned over during the manipulation therewith neither fuel nor water can pass through these pipes to the heating apparatus.

The length of the casing 27 is such that beneath the lower branch 36 there is sufficient room for the upper piston 30 when in its lower position to completely uncover the mouth of the branch 36. T

lower part of the casing 27 is formed with two annular grooves 41 and 42 which are in communication with each other as by a longitudinal groove and the upper one of which communicates with the branch 36 by a longitudinal groove 43. The purpose of these grooves is to allow compressed air which gradually gets under the piston 30 owing to its not being perfectly tight to escape again and to ensure that the air underneath the piston 30 shall always be at the same pressure as that emerging from the branch 36 whereby a difference of pressure is produced which keeps the piston in its lowest position during the whole run of the torpedo.

On opening the starting valve 3 the compressed air passes as heretofore stated through the regulator 5 to the retarding device 7 and at first, owing to the position of the piston 30, only a small part of the compressed air will pass, through the passage 40 and branch 36 into the pipe 8 and into the heating apparatus. By the continued pressure of the air however the two pistons 30 and 31 of the retarding apparatus are slowly forced downwardly, the lower piston acting as a brake piston. During this movement the three small branches 37, 38 and 39 are gradually opened so that the compressed air passes into the fuel reservoir 10 through the branch 37 and the [fol. 118] pipe 25 whereby the supply of the fuel commences. A moment later the compressed air also passes to the ignition apparatus through the branch 39 and the pipe 23 thereby setting the ignition apparatus in action. In this way the ignition of the fuel, which has already passed into the heating apparatus, is effected at a relatively low pressure. Immediately afterwards the compressed air also passes through the branch 38 and the pipe 24 into the water reservoir 20 whereupon the supply of water to the heating apparatus also commences. Finally the piston 30 which still keeps on moving downwardly, gradually and completely uncovers the outlet 36 to the heating aparatus, the pressure in the heating apparatus gradually rising until the piston 30 reaches its lowest position. The piston 30 is then kept in this lowest position owing to there always being, in consequence of the longitudinal groove 43 and annular grooves 41 and 42, a somewhat lower pressure below it than there is above it so that the tension of the spring is overcome.

When the torpedo has concluded its run the starting valve 3 is closed automatically after which the pistons 30 and 31 are returned to their uppermost position by the pressure of the spring 33.

The constructional formation of the improved pressure retarding apparatus and controlling device obviously permits of numerous modifications while ensuring the above described method of working and without departure from this invention. Thus for example instead of the upper piston 30 another suitable controlling device, say a slide valve, could be employed operated by a piston which is subject to the pressure of the compressed air for the purpose of obtaining the desired automatic movement.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed I declare that what I claim is:

N° 393.324

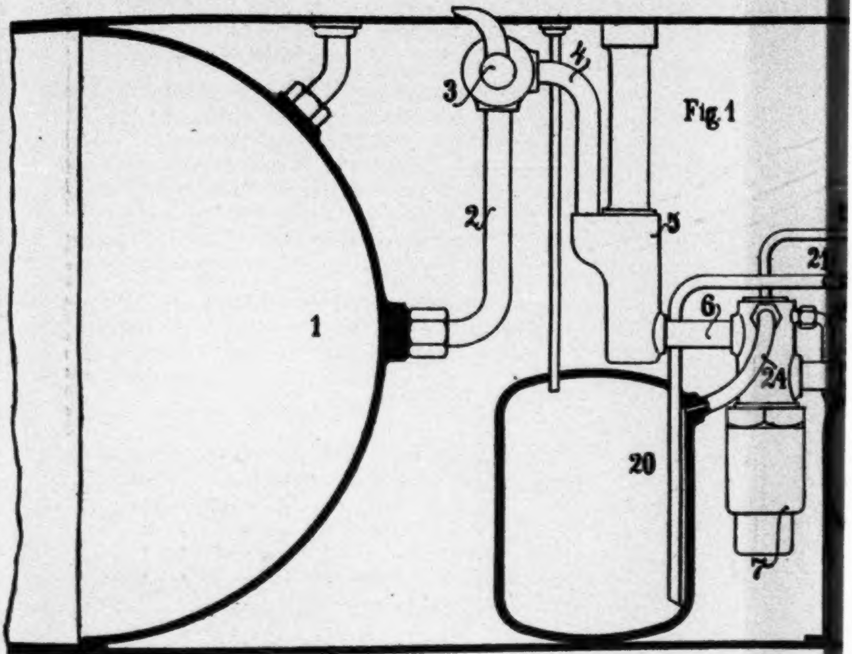

Fig. 1

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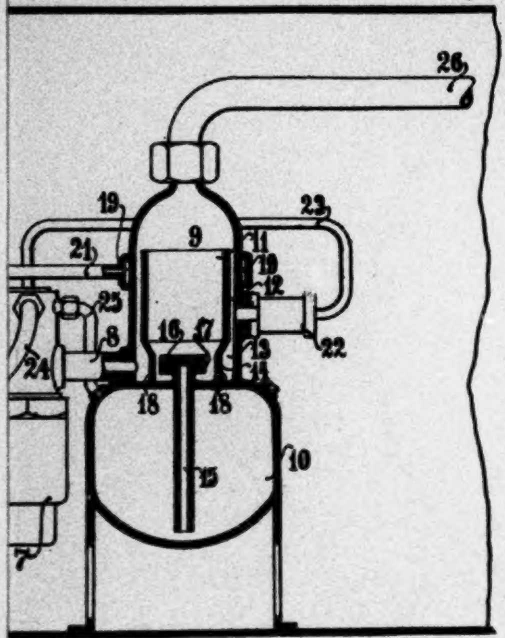


Fig.2

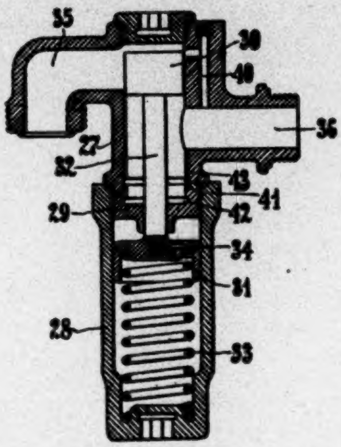


Fig.4

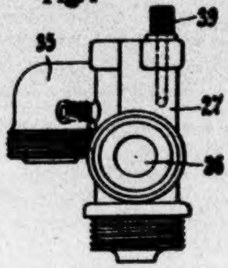


Fig.5

Coupe XX

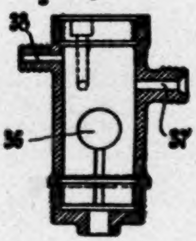
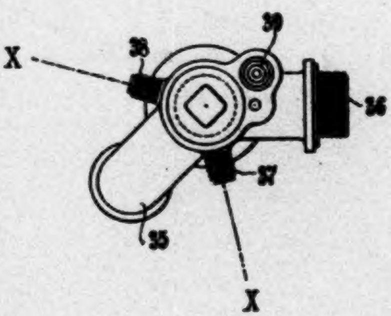


Fig.3



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1. Pressure retarding apparatus, for compressed air motor plants, of the kind wherein a piston valve, which is provided with a brake piston and acted upon by spring pressure or other controlling device acted upon by a piston, wholly or partially cuts off, when in its normal position, the outlet opening to the motor or to the compressed air heating apparatus, and, when it is displaced by the entering compressed air, gradually uncovers the outlet opening, characterised by the fact that the pipe connections with the fuel reservoir, the water reservoir, and the ignition device which is worked by compressed air, open into the piston valve casing in such way that when the piston valve or controlling device is in its normal position these connections are obstructed or shut off and are only gradually opened as the piston valve is moved by compressed air, so that the motor is started gently and without noise.

2. Pressure retarding apparatus according to Claim 1, in which the underside of the piston valve or the piston acting upon the controlling device, constantly communicates with the compressed air outlet opening for the purpose of keeping up a constant difference of pressure on the two sides of the piston valve in order to overcome the spring pressure and by this means to keep the piston in its lowest position during the entire run of a compressed air driven torpedo fitted with the apparatus.

3. Pressure retarding apparatus for compressed air motor plants of the kind referred to, constructed, arranged and operating substantially as hereinbefore described with reference to and shown in the accompanying drawings.

Dated this 31st day of August 1908.

For the Applicant, Lloyd Wise & Co., 46 Lincoln's Inn Fields, London, W. C., Chartered Patent Agents. (Seal of the Court of Claims.)

(Here follow side folio pages 119 and 120.)

[fol. 121] République Française

Office National De La Propriété Industrielle

Brevet D'Invention

No. 393.324

VI.—Marine et navigation.

1.—Construction des navires et Engins de Guerre.

Dispositif de retardement de pression automatique pour surchauffeur d'air pour torpilles.

M. Johann Gesztesy résidant en Hongrie.

Demandé le 20 juillet 1908

Délivré le 22 octobre 1908.—Publié le 19 décembre 1908

Dans le brevet français n° 373.757, du 27 mrs 1906, on a décrit un procédé et un dispositif pour augmenter le travail fourni par les moteurs à air comprimé, en particulier pour les torpilles automobiles, dans lesquels on mélange l'air comprimé, tout en maintenant sa tension, avec un combustible liquide finement divisé, celui-ci étant enflammé dans une chambre de chauffe spéciale, dans la quelle se produit une combustion continue pendent la marche du moteur, par suite de la chute de pression provoquée par cette marche. En même temps la quantité de matiére combustible offerte effectivement à la combustion est exactement délimitée par l'introduction d'une quantité déterminée de combustible soumis à la pression originelle de l'air comprimé; les gaz de la combustion sont ensuite mélangés avec de la vapeur d'eau, obtenue par l'introduction d'eau dans la chambre de chauffe et ce mélange à haute tension est réduit à la pression de fonctionnement.

En outre on a proposé un appareil de retardement de pression automatique, qui est intercalé entre le réservoir d'air comprimé et le moteur et est caractérisé par le fait que, dans une boîte intercalée sur la conduite d'air comprimé, sont disposés de façon mobile deux pistons réunis ensemble et soumis à une action de ressort, dont le plus grand agit comme piston-frein, tandis que le plus petit se compose d'une partie cylindrique obturant l'ouverture de passage de l'air et d'une partie rétrécie coniquement, située au-dessus de la précédente et pénétrant dans la chambre d'arrivée de l'air comprimé; cette dernière partie est pressée sur son siège, tant par le ressort que par l'air sous pression que remplit toute la conduite d'air comprimé lors du remplissage de la chaudière, mais, dès que la pression de l'air dans la conduite allant au moteur tombe par suite de la mise en marche de ce dernier, elle est déplacée par l'air comprimé agissant sur son autre face malgré l'action du ressort et du piston-frein, de telle sorte qu'elle donne libre passage à l'air suivant sa forme conique, après que sa partie cylindrique s'est complètement retirée de l'ouverture de passage.

L'invention ci-dessous décrite a pour objet une amélioration c'est-à-dire un perfectionnement des dispositifs en question, les dispositions perfectionnées garantissant alors dans son intégralité le mode de fonctionnement suivant:

1° La pression dans l'appareil de chauffe est, immédiatement après le départ du moteur, suffisamment diminuée pour que l'augmenta-

[fol. 122] tion de pression résultant du premier allumage du mélange de charge ne puisse avoir aucune conséquence nuisible pour le moteur;

2° Par l'augmentation graduelle de pression après l'allumage effectué, le moteur est mis peu à peu en action, ce qui met également le moteur à l'abri d'influences perturbatrices;

3° Les instants où commencent l'alimentation en eau et en combustible, et la mise en train du dispositif d'allumage sont réglés de manière à se succéder pour le fonctionnement le plus favorable;

4° Enfin le nouveau dispositif évite que, si la torpille se renverse accidentellement pendant qu'on la manipule, le combustible ou l'eau ne s'écoule hors des réservoirs appropriés dans la conduite c'est-à-dire dans l'appareil de chauffe et dans le machine.

Tout cela peut être obtenu de manière simple grâce à un dispositif de retardement de pression qui est en substance disposé comme celui susmentionné, mais avec cette différence qu'il renferme en même temps un mécainisme de distribution qui contrôle de manière convenable l'alimentation d'air, de combustible et d'eau.

Dans les dessins, la fig. 1 représente l'ensemble de l'installation pour une torpille, tandis que les fig. 2, 3, 4 et 5 font voir les organes de retardement de pression et de distribution, respectivement en coupe longitudinale, en plan, en élévation latérale et en coupe suivant *x-x* (fig. 3).

Du réservoir d'air comprimé 1, part un tuyau 2 vers la valve de mise en route 3, de laquelle un tuyau 4 mène au régulateur de pression 5. Celui-ci communique par le tube 6 avec l'appareil 7 de retardement de pression et de distribution hors duquel l'air comprimé s'échappe à travers la tubulure 8 dans l'appareil de chauffe 9. Ce dernier, ainsi d'ailleurs que les dispositifs d'alimentation de combustible et d'allumage, peuvent être construits comme représenté dans le mémoire descriptif joint au brevet n° 373.757 susmentionné. L'appareil de chauffe se compose également d'une enveloppe placée sur le réservoir à combustible 10, et dans laquelle un vase 11 ouvert en haute et entourant la chambre de combustion est établi de manière à laisser autour de lui un espace annulaire libre 12. Ce vase 11, qui peut être pourvu d'un diaphragme pour le mélange intime du combustible avec l'air comprimé, se rétrécit vers le bas suivant une espèce de tubulure cylindrique 14 reposant sur le réservoir à combustible 10 et entourée de l'espace annulaire élargi 13; dans cette tubulure pénètre vers le haut un tube élévateur 15 qui descend jusqu'auprès du fond du réservoir 10 et qui porte, à son orifice supérieur, un corps cylindrique 16 avec perforations radiales 17. Ce cylindre divise ainsi l'espace de l'appareil de chauffe à l'intérieur de la tubulure, 14 en deux compartiments communiquant par un rétrécissement annulaire. Le compartiment inférieur communique par les trous 18 aver l'espace annulaire 13 dans lequel débouche la tubulure 8. Sur la paroi latérale extérieure de l'enveloppe de l'appareil de chauffe est disposé un canal annulaire 19 qui communique d'une part avec le tuyau 21 conduisant au réservoir d'eau 20 et d'autre

part, grâce à des petits trous de l'enveloppe, avec l'espace annulaire 12 entourant le vase 11.22 este le dispositif d'allumage qui doit être mis en activité par l'air comprimé et qui communique par le tuyau 23 aver le dispositif 7 de retardement de pression et de distribution. Ce dispositif 7 communique en outre par le tuyau 24 avec le réservoir d'eau 20 et par le tuyau 25 avec le réservoir de combustible 10. Le conduit 26 mène au moteur.

Le réservoir 10 étant rempli de combustible et la valve de mise en route 3 étant ouverte, l'air sous pression arrive par les tuyaux 2 et 4, le régulateur de pression 5 et le dispositif de retardement de pression et de distribution ci-dessous décrit, à l'appareil de chauffe dont il remplit la capacité. Par le tube 25 il pénètre également dans le réservoir à combustible et chasse le combustible, à travers le tube élévateur 15 et les perforations radiales 17, vers la partie supérieure où ce combustible se mélange à l'air comprimé et est enflammé par le dispositif d'allumage mis simultanément en activité par l'air comprimé arrivant par le tube 23. En même temps, de l'eau est refoulée du réservoir 20 par le tuyau 21 dans le canal annulaire 19; cette eau passe par les trous de l'enveloppe de l'appareil de chauffe dans l'espace annulaire 12 où elle est finement pulvérisée par l'air sous pression qui s'y précipite, et se mélange à cet air. Ce mélange se [fol. 123] brasse dans la partie supérieure de l'appareil de chauffe avec les gaz de combustion chauds qui s'échappent, en même temps que l'eau pulvérisée se transforme en vapeur, le mélange finalement obtenu étant conduit au moteur pour utilisation de son énergie.

Pour pouvoir maintenant, c'est-à-dire lors du départ du moteur, régler convenablement le fonctionnement indiqué, l'appareil de retardement de pression et de distribution représenté à plus grande échelle par les fig. 2, 3, 4 et 5 est conformé comme suit.

Il se compose de deux chambres cylindriques 27 et 28 superposées séparées l'une de l'autre par une cloison intermédiaire 29. Dans chaque chambre se trouve un piston étanche, respectivement 30 et 31, ces deux pistons étant reliés ensemble rigidement ou de manière articulée par une tige 29 pouvant aller et venir dans une lumière ou un passage de la cloison intermédiaire 29. En dessous du piston inférieur 31 est disposé un fort ressort à boudin 33 qui tend à soulever constamment les deux pistons vers le haut. L'espace en dessous du piston 31 est en outre rempli d'un liquide de freinage. Le piston 31 est percé d'un étroit canal 34 à travers lequel le liquide de freinage est forcé, lorsque le piston est déplacé dans sa direction.

Dans la chambre supérieure 27 débouchent deux grosses et trois petites tubulures. La tubulure 35 sert pour l'arrivée d'air et est en conséquence reliée au tuyau 6 (fig. 1). La tubulure 36 située un peu plus bas sert à la sortie de l'air vers l'appareil de chauffe et est donc reliée au tuyau 8 (fig. 1). Entre ces deux tubulures 35 et 36 sont situées, à des niveaux déterminés, les trois plus petites 37, 38 et 39 qui servent respectivement aux connexions avec les réservoirs de combustible, d'eau et le dispositif d'allumage. Ces trois tubulures sont disposées de telle sorte que leurs orifices débouchant dans la chambre soient complétement fermés par le piston supérieur 30

lorsque celui-ci se trouve dans sa position la plus haute, position dans laquelle il laisse cependant un petit espace libre entre lui-même et le couvercle de la boîte 27. De cet espace libre restant au-dessus du piston 30, part un canal étroit 40, pratiqué dans la paroi de la chambre et se rendant à la tubulure 36 située plus bas, de manière que, dans la position susindiquée, une partie de l'air comprimé puisse déjà, passer de la tubulure 35 à la tubulure 36.

Tant que l'appareil est au repos, le piston 30 obture hermétiquement les deux conduits allant aux réservoirs de combustible es d'eau, de telle sorte que, si pendant sa manipulation la torpille se renverse, ni le combustible, ni l'eau ne peuvent parvenir par ces conduits dans l'appareil de chauffe.

En dessous de la tubulure inférieure 36, on a encore ménagé dans la chambre 27 assez de place pour que le piston supérieur 30, lorsqu'il est dans sa position la plus basse, laisse complètement découvert l'orifice de la tubulure 36. Au bas de la chambre 27 sont pratiquées deux rainures circulaires 41 et 42 dont la supérieure communique avec la tubulure 36 par une saignée longitudinale 43. Ceci a pour but de laisser de nouveau échapper l'air sous pression qui arrive progressivement sous le piston 30 par suite de la nonétanchéité de ce dernier, et de maintenir constamment l'air qui se trouvre en dessous du piston 30 à la même pression que celui qui s'échappe par la tubulure 36; grâce à cela, on assure une différence de pression qui maintient fortement le piston à sa position la plus basse pendant toute la course de la torpille.

Au moment où l'on ouvre la valve de mise en route 3, l'air comprimé se rend également à travers le régulateur de pression 5 au dispositif retardateur 7 et une petite portion seulement de cet air comprimé par le canal 40 dans le tuyau 8 et dans l'appareil de chauffe. La pression de l'air refoule lentement verse le bas les deux pistons 30 et 31 du dispositif retardateur, le piston inférieur 31 agissant comme frein. Par suite les orifices des trois petites tubulures 37, 38 et 39 s'ouvrent successivement de telle façon que l'air sous pression arrive en premier lieu, par le tuyau 25, dans le réservoir à combustible 10, ce qui fait commencer l'alimentation en combustible. Un moment apres, l'air comprimé arrive également par la conduite 23 au dispositif d'allumage 22 qu'il met en activité. Ainsi s'effectue l'allumage du combustible arrivant dans l'appareil de chauffe sous une pression relativement faible. Ensuite l'air com-
[fol. 124] primé parvient également par le tuyau 24 au réservoir d'eau 20, cequi met en route l'alimentation d'eau dans l'appareil de chauffe. Enfin, le piston se déplaçant toujours de plus en plus vers le bas découvre progressivement jusqu'à ouverture complète la sortie vers l'appareil de chauffe, ce qui fait que la pression dans cet appareil s'accroît peu à peu jusqu'à ce que le piston 30 ait atteint sa position la plus basse. Le piston est alors maintenu fortement dans cette position par le fait que la pression régnant sur sa face inférieure reste grâce aux rainures longitudinale 43 et annulaires 41 et 42, constamment plus faible que celle régnant sur sa face supérieure, de manière à vaincre la tension du ressort.

Lorsque la torpille a terminé sa course, la fermeture de la valve de mise en route s'opère automatiquement, ce qui a pour effet de faire revenir les pistons 30 et 31 à leur position la plus haute par suite de la poussée du ressort.

Les dispositions de construction de ce dispositif de retardement de pression et de distribution peut bien entendu supporter des modifications variées à condition de respecter le mode de fonctionnement indiqué ci-dessus. Par exemple le piston supérieur 30 pourrait être remplacé par un autre organe de distribution, comme un tiroir, qui serait contrôlé, pour déplacement automatique, par un piston soumis à l'action de l'air comprimé.

RÉSUMÉ

L'invention porte plus particulièrement sur les points suivants:

1° Un dispositif retardateur de pression pour installations de moteurs à air comprimé dans lequel un piston-tiroir ou autre organe de distribution contrôlé par un piston réuni à un piston-frein et soumis à l'action d'un ressort, obture complètement ou partiellement dans sa position normale l'orifice de sortie vers le moteur ou vers l'appareil de chauffe de l'air comprimé, et découvre au contraire peu á peu cet orifice de sortie lorsqu'il est déplacé par l'air comprimé, caractérisé par le fait que, des tuyaux de jonction respectivement avec le réservoir de combustible, le réservoir d'eau et le dispositif d'allumage à mettre en train par l'air comprimé, débouchent dans la chambre du piston-tiroir de façon à être obturés dans la position normale du tiroir à piston ou organe de distribution, et à être ensuite découverts l'un après l'autre par le déplacement du tiroir à piston provoqué par l'air comprimé, de telle sorte que le départ du moteur s'effectue avec douceur;

2° Le mode d'exécution caractérisé par le fait que la face postérieure du tiroir à piston c'est-à-dire du piston contrôlant l'organe de distribution, reste constamment en communication avec l'orifice de sortie, dans le but de maintenir entre les deux faces du piston-tiroir une différence de pression constante qui permette de vaincre la poussée du ressort et de maintenir ainsi le piston dans sa position la plus basse pendant toute la course de la torpille.

Johann Gesztesy. Par procuration: G. Protte.

[fol. 124½] REVISTA MARITIMA BRAZILEIRA

Parafusos para a ligação da cabeça	22
Parafusos para o fluctuador	20
Parafusos para a cauda	12

O torpedo com a cabeça de combate, o reservatorio carregado a 80 atm. e a machina sem agu deverá ter a fluctuabilidade de 4 a 5 kg., n'agua de densidade 1.027 e temperatura de 17° C.

O apparelho Obry para estes torpedos será feito de modo que o

angulo de lançamento possa ser dado ou alterado pela parte externa do torpedo.

AQUECEDOR DE AR PAIA TORPEDOS, SYSTEMA GESZTEZY

Dos apparelhos destinados ao aquecimento do ar durante a carreira do torpedo e presentemente em experiencias na casa Whitehead, parece-nos que o aquecedor inventado pelo 1° tenente Gesztezy, da marinha austriaca, será o preferido, si as provas de lançamento tiverem o mesmo resultado que as experiencias preliminares.

Até agora a principal vantagem deste apparelho sobre o Armstrong é permittir que a machina do torpedo conserve todas as suas peças de bronze, o que não acontece com o aquecedor inglez, no qual, devido á sua temperatura, torna-se necessario o emprego do aço nos embolos e valvulas de distribuição, sendo portanto mais difficil a conservação do motor.

Não nos é possivel dizer em que consiste o funccionamento do aquecedor Armstrong, porque os dois torpedos em que este apparelho faz suas experiencias não são desmontados á vista de estranhos.

[fol. 125] Quanto, porém, ao aquecedor Gesztezy, cujas experincias preliminares não foram secretas e cujo schema pudemos obter, faremos o possivel para dar uma idéa geral do seu funccionamento.

No torpedo em que este aquecedor está montado, elle occupa o compartimento dos reguladores de immersão, usando o torpedo o novo apparelho de immersão collocado no compartimento da machina.

O fim do aquecedor Gesztezy é converter aos poucos em vapor a agua contida num reservatorio, sequindo este com o ar a desempenhar na machina o papel de ar aquecido.

O apparelho completo compõe-se do seguinte:

Apparelho aquecedor propriamente dito E.

Apparelho retardador I.

Deposito de combustivel (benzina) F.

Deposito d'agua G.

Pistola H.

O apparelho aquecedor é constituido pela campanula externa T, tendo no interior o vaso cylindrico t que limita o espaco para a combustão, ficando entre elle e a campanula externa o espaco circular d.

O vaso interno t diminue de diametro na parte inferior f, formando-se o espaco circular maior e; na parte inferior de t sahe o tubo a que termina na parte superior por um corpo cylindrico g, onde existem os furos alongados h.

Por meio deste corpo, a parte de menor diametro de t fica dividida em duas partes, apenas em communicação por meio dum pequeno espaço circular, ficando ainda a parte inferior em communicação com o espaço e por meio dos furos i.

[fol. 126] Na campanula T existe o canal circular l em communicação com o tubo conductor d'agua m, e por meio dos furos n, com o espaço *t*.

Ao apparelho aquecedor é fixa a pistola H, onde um pequeno car-

tucho é detonado por percussão pela pressão do ar, trazido á pistola pelo tubo r.

Os depositos de combustivel e agua F e G são simples vasos onde existem dous tubos, um para sahida do liquido, outro para entrada do ar.

O regulador de pressão D é o mesmo usado nos torpedos.

O funccionamento do apparelho é o seguinte:

O ar vindo do reservatorio, ao encontrar abertas as valvulas de conservação e admissão, segue pelo tubo k para o regulador de pressão, donde, depois de reduzido á pressão conveniente, segue para o apparelho retardador I; dahi os tubos de pequeno diametro p, o, r conduzem ar aos depositos d'agua, de combustivel e á pistola.

Terminado o trabalho no apparelho retardador, o ar segue para o aquecedor pelo tubo k'' que termina no espaço circular e; ahi o ar se divide em duas partes, uma pequena parte penetra palos furos i, arrastando a benzina que sahe aos poucos pelos furos h, para o meio do vaso *t*, onde a mistura se inflamma; a outra parte do ar segue pelo espaço d para a parte superior do apparelho, arrastando e dispersando a agua, que sahe aos poucos pelos furos n.

Na parte superior do apparelho dá-se então a união dos productos da combustão com o ar impregnado d'agua, sendo esta instantaneamente convertida em vapor e seguindo com o ar para a machina, pelo tubo M.

[fol. 127] O apparelho retardador, cuja vista interna o schema não mostra, é a parte principal do apparelho, constituindo, segundo ouvimos, uma patente separada.

O fim deste apparelho é só permittir uma pressão minima nos primeiros momentos da carreira do torpedo, augmentando-a gradativamente até a normal.

O apparelho do tenente Gesztezy apresenta ainda as seguintes vantagens:

1.ª O primeiro accendimento da mistura dá-se com muito pequena pressão, de modo que o augmento repentino de pressão, devido ao accendimento, não póde ter nenhuma consequencia desvantajosa para o motor.

2.ª Nos lançamentos o apparelho só permitte que a machina trabalhe a toda força depois de ter o torpedo entrado n'agua, tornado-se portanto desnecessario o retardador usado actualmente.

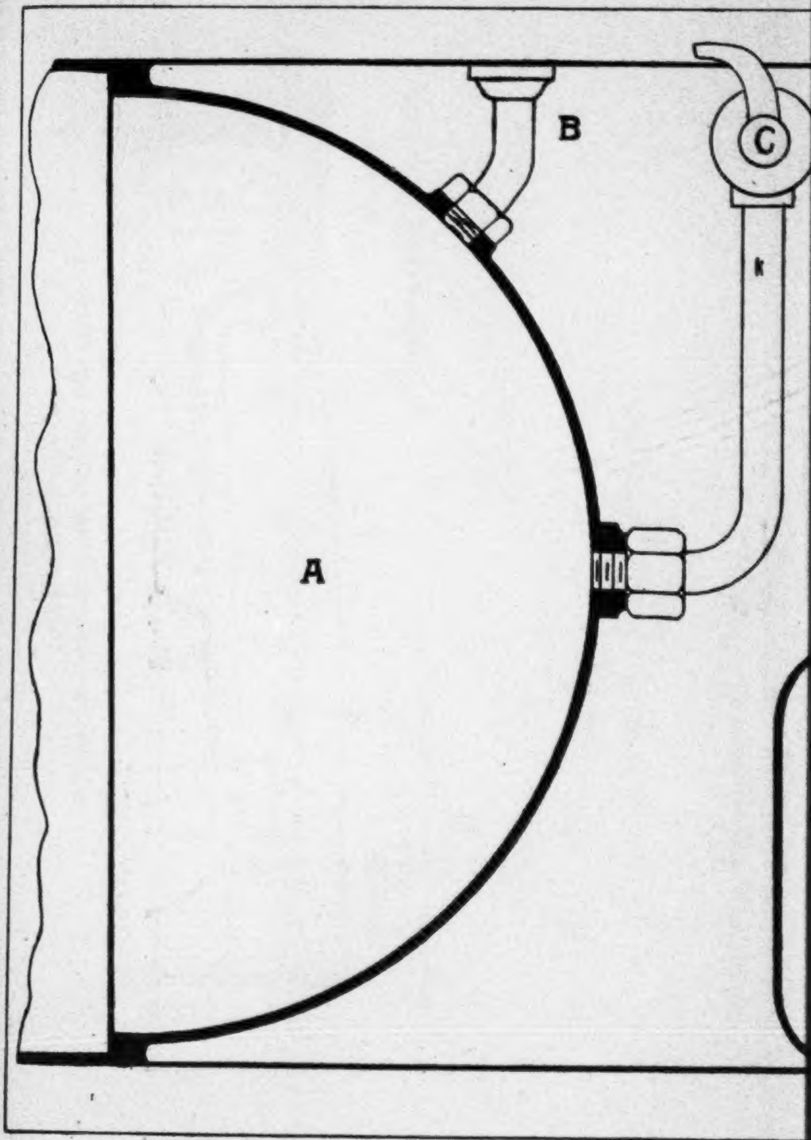
3.ª Mediante uma conforme disposição dos tubos de conducção de ar, póde-se regular exactamente o momento de introducção da benzina e da agua, como tambem o instante do accendimento.

O apparelho como está actualmente pesa, com os depositos cheios, 25 kg., tendo o deposito d'agua a capacidade de 8^{l}, 5 e o de benzina a de 1^{l}, 1.

Fiume—Novembro de 1907.

L. Neves, 2° Tenente.

(Here follows side folio page 128.)



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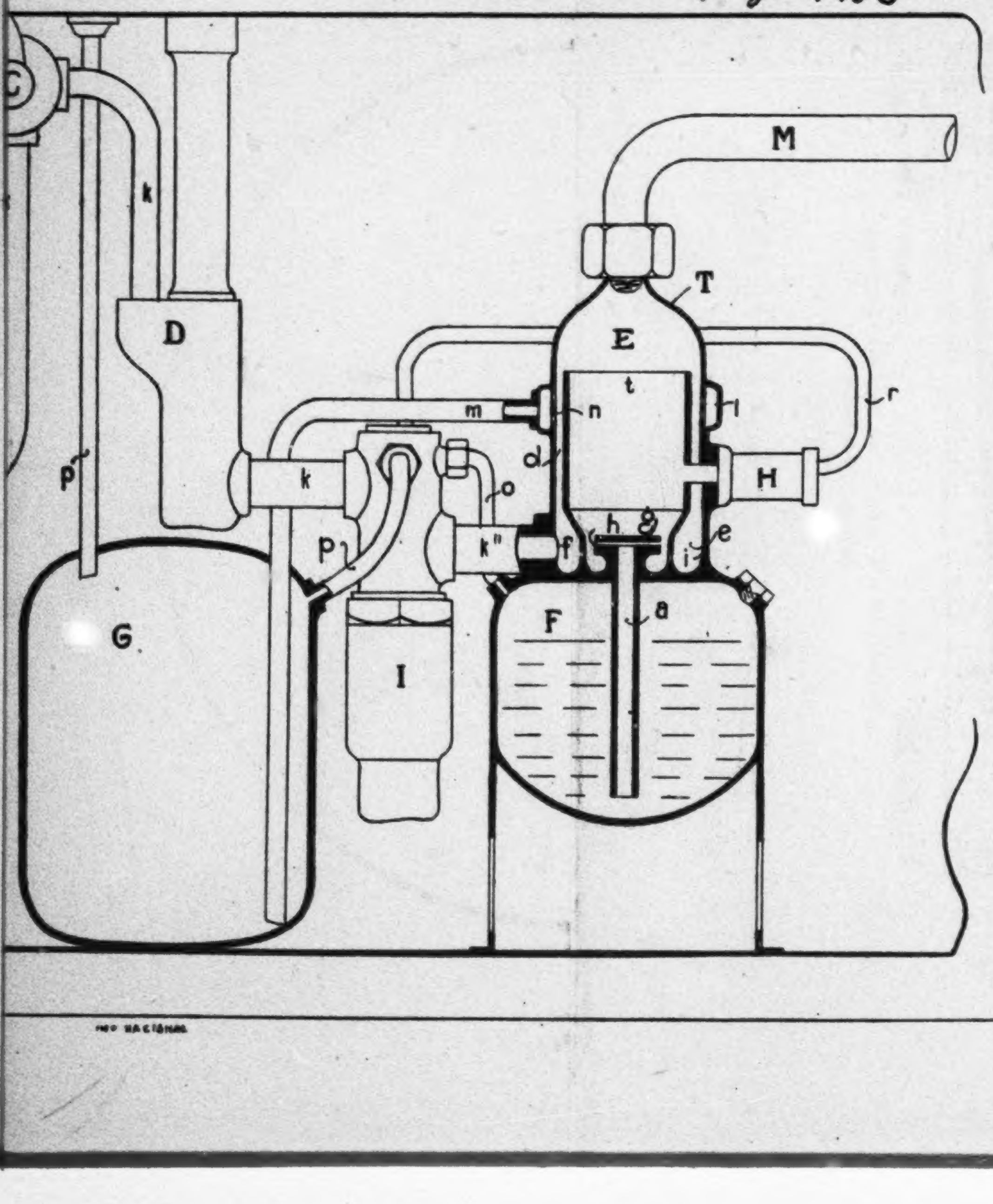
page 128



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Pages 135-136

Fig. 1

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G-15
To Courts findings

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AUTOMOBILE TORPEDO.

APPLICATION FILED MAR. 19, 1908. RENEWED JULY 3, 1912.

1,036,082. Patented Aug. 20, 1912.

6 SHEETS—SHEET 1.

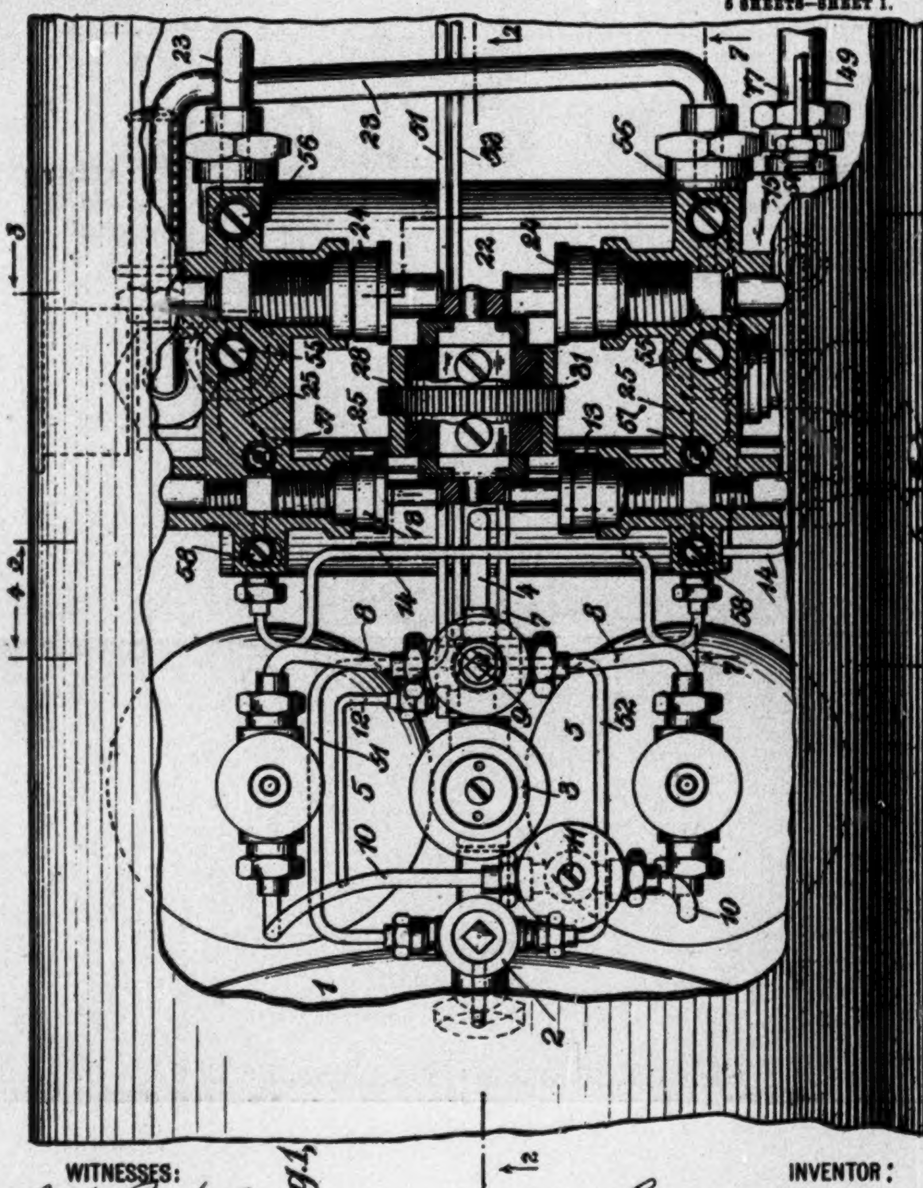

Fig. 1.

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C—15
To Court's findings

Pages 135–136

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APPLICATION FILED MAR. 19, 1908. RENEWED JULY 3, 1912.

1,036,082. **Patented Aug. 20, 1912.**

5 SHEETS—SHEET 2.

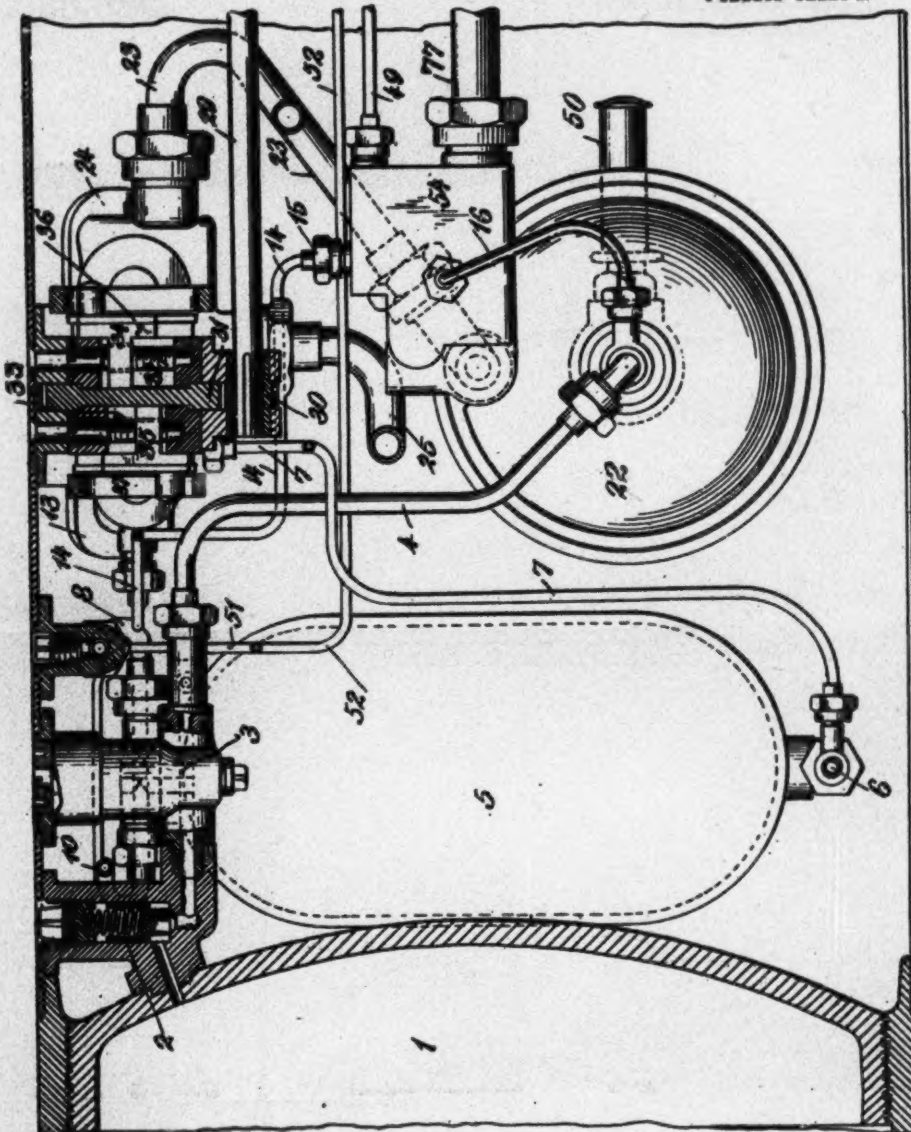

Fig. 2,

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APPLICATION FILED MAR. 19, 1906. RENEWED JULY 3, 1912.

1,036,082. Patented Aug. 20, 1912.

5 SHEETS—SHEET 3.

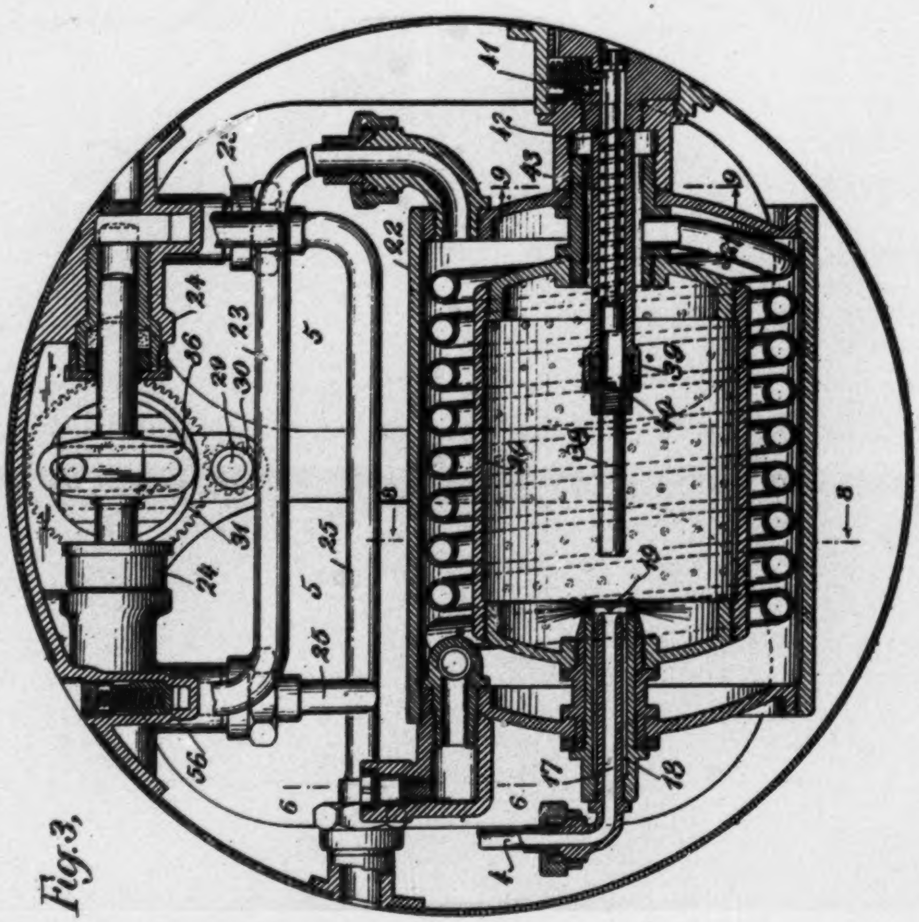

Fig. 3,

WITNESSES:
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AUTOMOBILE TORPEDO.

APPLICATION FILED MAR. 19, 1908. RENEWED JULY 8, 1912.

1,036,082.

Patented Aug. 20, 1912.

5 SHEETS—SHEET 4.

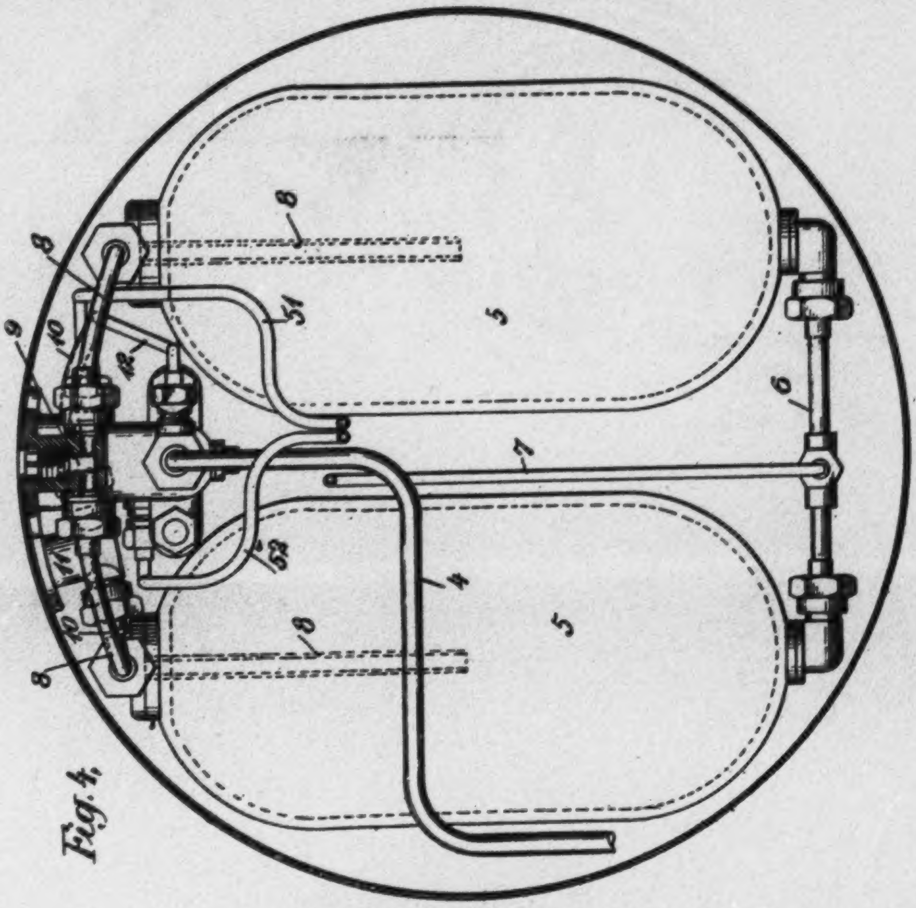

Fig. 4.

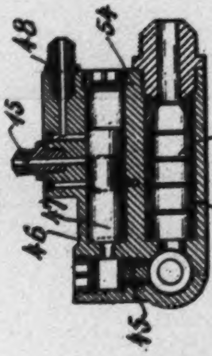

Fig. 6,

WITNESSES:
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AUTOMOBILE TORPEDO.

APPLICATION FILED MAR. 10, 1908. RENEWED JULY 3, 1912.

1,036,082.

Patented Aug. 20, 1912.

5 SHEETS—SHEET 5.

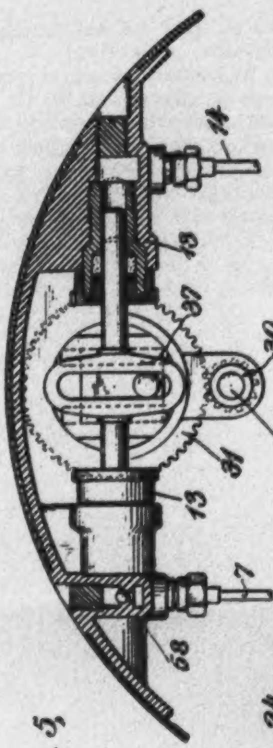

Fig. 5.

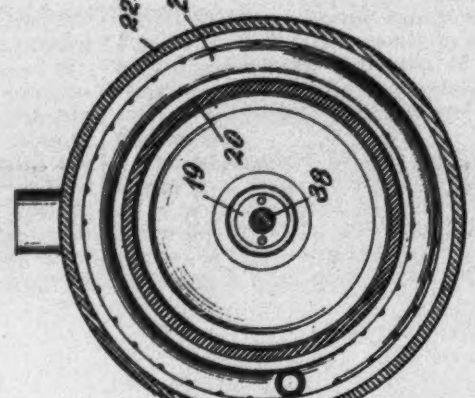

Fig. 8.

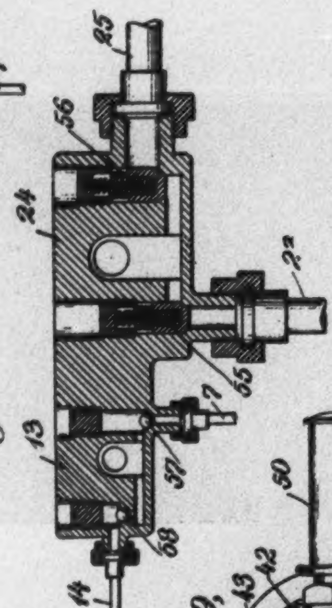

Fig. 7.

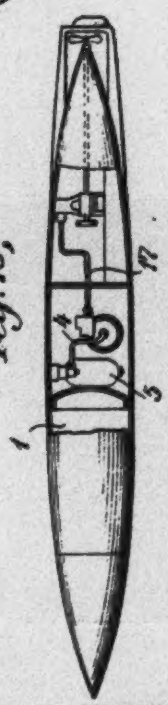

Fig. 10.

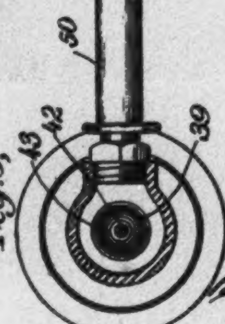

Fig. 9.

WITNESSES:

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L. B. Penfield

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by

[illegible]

ATTORNEYS.

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UNITED STATES PATENT OFFICE.

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AUTOMOBILE TORPEDO.

1,036,082. Specification of Letters Patent. Patented Aug. 20, 1912.

Application filed March 19, 1908, Serial No. 422,175. Renewed July 3, 1912. Serial No. 707,606.

To all whom it may concern:

Be it known that I, GREGORY CALDWELL DAVISON, a citizen of the United States, residing at Quincy, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Automobile Torpedoes; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

It has been common practice to propel automobile (or self-propelled) torpedoes by compressed air, which is fed from a storage reservoir to a suitable motor attached to the propeller shaft of the torpedo. It is of primary importance to reduce the size and weight of the parts in such torpedoes to the minimum, and to secure the maximum of energy from the motive power carried; because the available space is closely limited, and the range of the torpedo can only be added to by reducing the weight and increasing the efficiency of energy transformation. In order to increase the energy obtainable from the air carried in torpedoes propelled by compressed air, the air has sometimes been superheated before passing to the engine by burning in the air a certain amount of liquid fuel. But on account of the construction of the very light, high speed, powerful engines used in such torpedoes, the highest degree of heat theoretically obtainable is not practically available, since these engines must be operated at a moderate temperature. The result is that the fuel must be limited considerably below the amount which could combine with all the oxygen of the air in burning, and consequently the full efficiency of energy transformation is not secured.

The object of the present invention is to provide improved means whereby all the oxygen of the air may be used in combustion, or preferably, whereby compressed oxygen is carried instead of compressed air, and all of the oxygen is used for combustion; and then to overcome the objectionably high temperatures and preserve the released energy by providing means whereby the heat evolved by the combustion is utilized to form steam and the steam thus formed, with the cooled products of combustion, is delivered at the engine at a suitable temperature. By so doing, the total amount of work obtainable from the materials carried in the limited space of the torpedo will be largely increased, thereby largely increasing the range of the torpedo. It is further aimed to provide such means which admit of close regulation and safe control of the large forces employed; and to make it possible to continue the use of the light high speed powerful engines which are now used, and which require a very high working pressure and a moderate temperature.

The particular nature of the means employed will be understood from the following description and the accompanying drawings, in which there is described and illustrated the best form now known to me in which the invention may be embodied. The apparatus employed, however, is one which necessarily includes many known elements, and in which the different coöperating elements may assume many different equivalent forms.

In the drawings: Figure 1 is a top plan view of a portion of the torpedo, the shell being broken away to disclose the mechanism within it. Fig. 2 is a central longitudinal section on the line 2—2 of Fig. 1, with the generator and mixer in elevation. Fig. 3 is a cross section, on the line 3—3 of Fig. 1. Fig. 4 is a cross section on the line 4—4 of Fig. 1. Fig. 5 is a fragmentary cross section of the upper portion of the torpedo on the line 5—5 of Fig. 1, showing the fuel pump partly in section and partly in elevation. Fig. 6 is a longitudinal section (on the line 6—6 of Fig. 3) of the mixer and one of the safety devices. Fig. 7 is a fragmentary cross section on the line 7—7 of Fig. 1, showing the arrangement of valves of the fuel and water pumps. Fig. 8 is a cross section of the generator on the line 8—8 of Fig. 3. Fig. 9 is a cross section of one end of the generator on the line 9—9 of Fig. 1 showing another safety device, and Fig. 10 is an elevation partly in section and partly of a diagrammatic character, of the whole torpedo, showing the arrangement of the storage reservoirs, generator and engine in the torpedo.

The compressed air (or oxygen) is contained in a flask 1 formed by partitioning off a portion of the shell of the torpedo. From this flask the compressed air or oxygen is led to the generator through a starting valve 2, a reducing valve 3 and pipe 4.

The starting valve 2 is of known construction and is opened, upon launching the torpedo, by mechanical or other means, allowing the air (or oxygen) to pass through the reducing valve 3, which may be of any suitable construction and which reduces the air (or oxygen) to the working pressure. In the particular construction shown the starting valve is controlled through pipes 51 and 52 which extend to the ordinary tripping-latch cock (not shown). Up to this point the operation accords with the usual practice and no claims for novelty are made. The liquid fuel is carried in a suitable receptacle which in the form shown consists of two tanks 5 connected at their lower ends by an equalizing pipe 6 from which the fuel take-off pipe 7 leads. These flasks are provided with filling pipes 8 which branch from a filling orifice 9 closed by a screw-plug, when not in use. They are also provided with vent connections 10 extending to a vent orifice 11 which is also closed by a screw-plug when not in use. In filling, the vent and filling pipes are open; after filling they are closed. A connecting pipe 12 extends from the reduced air pressure to one of the branches of the vent pipes, thereby admitting the reduced air pressure to the flasks. The fuel take-off pipe 7 leads to one side of the fuel pump 13 and from the other side of that pump it is fed through the pipe 14 to the inlet 15 of the safety device in casing 54 (see Fig. 6) and through that device and the pipe 16 to the generator.

From Fig. 3 it will be seen that the air enters the burner of the generator through a tubular extension 17 of the pipe 4 which is surrounded by a chamber 18 with which the fuel supply pipe 16 communicates. The air or oxygen and the fuel, both under pressure, are forced through this tubular extension 17 and the surrounding space 18 against a cap 19 by which they are thrown out laterally in the form of a spray into the combustion chamber and are thoroughly mixed together. By means to be described later, the mixture of fuel and oxygen is ignited as soon as the torpedo is started. As the pressure in the combustion chamber is arranged to be four or five hundred pounds per square inch combustion will be very rapid. If pure oxygen be used instead of air, the resultant temperature would be very high. To withstand the high pressure the combustion chamber is made in the form of a strong cylinder 20. The intensely heated products of combustion pass from the combustion chamber through the open sleeve at the right hand end thereof (Fig. 3) into a strong perforated coil 21 which is within an outer casing 22 surrounding the combustion chamber. Water under pressure is supplied to this surrounding chamber through the water supply pipes 23 connected to the discharge orifices of the water pump 24 which is supplied from the external water through the pipes 25. This water is under sufficient pressure to be forced through the perforations in the pipe 21 against the pressure of the highly heated products of combustion therein, and the small streams of water flowing into the coil through the perforations mix with the heated gases, the water being converted into super-heated steam and the gases at the same time being cooled by the conversion. In other words, the water absorbs heat from the gases forming steam, so that the resultant mixture, while remaining at the working pressure, is of a lower temperature, and of greatly increased volume. The temperature of the steam and cooled gases will depend upon the proportion of oxygen, fuel and water used. From the coil 21 the gases pass into the mixer 26 (see Fig. 6) which comprises a chamber containing a series of gauze partitions 27. The object of the mixer is to heat up any drops of water which may be carried through the coil and cause them to form steam by contact with any strata of unduly heated gases which might get through the coil, and thus insure a uniform mixture at constant temperature being delivered at the engine through the pipe 77. It will be observed that the water in the outer chamber 22 serves to protect the combustion chamber from the heat inside, and also prevents the loss of heat by conduction, since such heat is absorbed by the water which subsequently passes into the coil to form steam.

The fuel pump 13 and the water pump 24 are both worked from the same yoke 28, carried to the main engine shaft 29, by the pinion 30 and the gear 31. Both of these pumps are of the single acting plunger type, with inlet check valves 55 and 57 and outlet check valves 56 and 58, and have an adjustable stroke provided by the adjusting screws 32 for the water pump and 33 for the fuel pump (see Fig. 2). It will be observed that by screwing in or out the screws 32 and 33 the distance at which the crank arms 34 and 35 are offset from the center is varied, thereby varying the extent of movement of the slotted yokes 36 and 37 and correspondingly varying the length of the pump stroke.

The ignition of the mixture of oxygen and fuel is accomplished, at starting, by means of the fuse 38 (see Fig. 3) in the carrier 39. The fuse is made of inflammable material such as cordite or smokeless powder and has on its end a percussion cap 40. When the torpedo is started and the air (or oxygen) under pressure enters the combustion chamber, the piston 41 is raised, the rod 42 is released, and is forced by the spring 43 in a direction to cause the striker 44 to explode the percussion cap and ignite the fuse,

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which thereupon starts the combustion of the mixed fuel and air or oxygen.

Safety devices are provided as follows:— To prevent injury from undue heat, such as would ensue should the supply of water fail from any cause, a fusible plug 45 (see Fig. 6) is inserted in the circuit of mixed steam and cooled gases. Under normal circumstances the temperature to which this plug is exposed will be well below its melting point. But when very high temperatures are met with, as when no water is supplied, this plug will melt before any other part of the apparatus is injured. When the plug melts, the passage normally closed by it will be opened. This passage leads to a cylinder 46 containing a piston 47 which is cut away at the central portion to afford, when in the position shown in Fig. 6, a communication from the fuel inlet 15 to the outlet communicating with the fuel pipe 16, as previously described. It will thus be seen that in this position the piston allows a free passage for the fuel from the fuel pump to the burner. When the plug is melted, the piston moves under pressure to the right in Fig. 6, and closes the exit passage for the fuel and puts the inlet passage into communication with the outlet 48 which leads overboard through the pipe 49. This action shuts off the supply of fuel to the burner and stops combustion. When this happens the torpedo will continue to run, using only the compressed air or oxygen as motive power. On account of the timing of ignition, or from other causes, there may occur at times in the combustion chamber very high pressures. To prevent injury, by relieving such pressure, a safety valve 50 of any suitable construction is attached to the sleeve forming the outlet from the combustion chamber (see Fig. 9).

The operation may be briefly described as follows:—In preparing the torpedo for use the tanks 1 and 5 are filled with compressed air or oxygen and with fuel, respectively, and all the parts are properly adjusted. As the torpedo leaves the firing tube the starting valve is lifted and the air or oxygen passes through the reducing valve, the generator, and the plate 17 into the engine to start it. At the same time, the pressure of the air or oxygen ignites the fuse. After the first few strokes of the engine, fuel and water will begin to flow. The mixture of fuel and air (or oxygen) coming in contact with the burning fuse will ignite; and thereafter the highly heated products of combustion have their heat absorbed by the water flowing through the perforations in the pipe 14 and the mixture of cooled gases and steam passes to the engine to operate it. It will be observed that this arrangement affords a means of attaining the maximum amount of mechanical work from a given amount of compressed fuel and oxygen-carrying substance; and that at the same time it admits of safe control and accurate regulation of the large forces employed, and can be used with the very light high speed powerful engines now used in torpedoes, which engines require a very high working pressure and moderate temperature.

Many of the coöperating parts of the apparatus described above are such as may be replaced by a skilled mechanic by equivalent parts of many different forms and yet retain the advantageous mode of operation of the invention, and I do not intend to limit myself to the use of the particular forms of apparatus disclosed; intending on the contrary to retain the liberty of availing myself of all other equivalent arrangements in which the invention may be embodied.

What I claim is:—

1. An apparatus for generating motive fluid for automobile torpedoes, comprising a strong inner casing forming a combustion chamber capable of withstanding high pressure and having means for supplying a combustible and an oxygen-carrier to said chamber and for igniting them therein, in combination with an outer casing surrounding said inner casing, a coiled perforated pipe surrounding the inner casing within the outer casing and forming an exit passage for the products of combustion, and means for supplying water under pressure to the space between the inner and outer casings whereby the water is forced in jets through the perforations into the products of combustion, and is converted into steam and mixed with the cooled gases; substantially as described.

2. In an apparatus for generating motive fluid for automobile torpedoes, a casing forming a combustion chamber and having means for supplying a combustible and an oxygen-carrier to said chamber in combination with a carrier supporting an ignition fuse having a percussion cap, a spring-actuated striker for said cap, a latch for restraining the striker, and mechanism actuated by pressure in the combustion chamber to release the latch and allow the striker to strike the percussion cap; substantially as described.

3. In an apparatus for generating motive fluid for automobile torpedoes, a casing 20 forming a combustion chamber and having a tubular inlet 17 for an oxygen carrier under pressure and a surrounding inlet 18 for a combustible under pressure, together with the deflecting plate 19 for throwing the mixed combustible and oxygen carrier into the combustion chamber in the form of a spray, a carrier 39 supporting an ignition fuse 38 having a percussion cap, a spring-actuated striker 44 normally restrained by a latch carried by a piston 41, the piston

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chamber being in communication with the combustion chamber, whereby pressure in the combustion chamber releases the striker, an outer casing 22 surrounding the casing 20, a perforated coiled pipe 21 in the space between the casing 22 and the casing 20 and forming an outlet from the combustion chamber, means for forcing water under pressure into the chamber between the two casings, whereby jets of water are forced through the perforations in the pipe 21 into the heated products of combustion from the combustion chamber to form steam and cool the products of combustion, a mixer in the path of the mixed steam and cooled gases, and a safety device also in the path of said gases operated by an excessively high temperature to shut off the supply of fuel to the generator; substantially as described.

4. A combined mixer and safety device for attachment to a generator of the character described comprising a casing 54 containing a chamber 26 in which gauze partitions 27 are supported, a fusible plug 45 normally closing a passage to a piston chamber 46 containing a piston 47 which controls the flow of fuel to the generator; substantially as described.

5. In an apparatus for generating motive fluid for automobile torpedoes, a casing forming a combustion chamber capable of withstanding high pressure and temperature and having means for supplying a combustible and an oxygen carrier to said chamber and for igniting them therein, a perforated extension of said chamber into which the hot products of combustion pass, a water jacket about said extension, and means for supplying water under pressure to said jacket, whereby the heated water in the water jacket is forced in jets through the perforations into the products of combustion, and is converted into steam and mixed with the cooled gases, substantially as described.

6. In an apparatus for generating motive fluid for automobile torpedoes, a casing forming a combustion chamber capable of withstanding high pressure and temperature and having means for supplying a combustible and an oxygen carrier to said chamber and for igniting them therein, a perforated extension of said chamber into which the hot products of combustion pass, a water jacket surrounding the combustion chamber and its extension, and means for supplying water under pressure to said jacket, whereby the heated water in the water jacket is forced in jets through the perforations into the products of combustion, and is converted into steam and mixed with the cooled gases, substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

GREGORY CALDWELL DAVISON.

Witnesses:
F. L. BRAKE,
W. D. FESLER.

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[fols. 129-133] **Translation made by Translator of the State Department**

GESZTEZY AIR WARMER FOR TORPEDOS—Omitted; printed side page 37

[fol. 134] C–14 To Court's findings.

(Here follow side folio pages 135-144, inclusive.)

[fol. 145] SUPREME COURT OF THE UNITED STATES

[Title omitted]

STIPLUATION FOR ADDITION TO RECORD—Filed Nov. 20, 1923

It is hereby stipulated and agreed by and between counsel for the parties hereto that Exhibit C-3 referred to in Finding XIV of the Findings of Fact, be added to the record herein on appeal from the judgment of the United States Court of Claims.

Dean S. Edwards, Counsel for Appellant. James M. Beck, Counsel for Appellee. Dated November 20, 1923.

Approved. H. E. K.

[File endorsement omitted.]

SUPREME COURT OF THE UNITED STATES, OCTOBER TERM, 1923

No. 159

ELECTRIC BOAT COMPANY, Appellant,

v.

THE UNITED STATES, Appellee

STIPULATION TO CORRECT RECORD

It is hereby stipulated and agreed by and between Counsel for the parties hereto that British Patent No. 15977 of 1906 included as Exhibit C-8 on pages 48, 49 and first four (4) lines of page 50 of the record be removed therefrom, and British Patent No. 15997 of 1906, which is the correct Exhibit C-8, be inserted in its place without renumbering the remaining pages of the record.

It is further stipulated and agreed that the index be corrected accordingly without reprinting the same.

A copy of British patent No. 15997 of 1906 is attached hereto.

Dean S. Edmonds, Counsel for Appellant. James M. Beck, Counsel for Appellee. H. E. K.

Dated January 2nd, 1924.

Supreme Court of the United States

OCTOBER TERM, 1923.

No. 159.

ELECTRIC BOAT COMPANY,

Appellant,

vs.

THE UNITED STATES.

APPEAL FROM THE COURT OF CLAIMS.

BRIEF FOR APPELLANT.

FREDERICK P. FISH,
WILLIAM H. DAVIS,
DEAN S. EDMONDS,
Counsel for Appellant.

PRESS OF FREMONT PAYNE, INC., 30 Washington St., New York City.

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LIST OF CASES.

Supreme Court of the United States

ELECTRIC BOAT COMPANY vs. THE UNITED STATES.	October Term, 1923. No. 159.

BRIEF FOR APPELLANT.

This appeal is from a judgment of the Court of Claims in a suit brought by Electric Boat Company to secure payment of royalty due under a license agreement dated April 2, 1912. The license provides for the payment of a fixed royalty to the Electric Boat Company for the use of certain patented inventions in torpedoes constructed for the United States "either in its own shops or by contract in private shops." Four patents are covered by the license but only one of them is directly involved in this suit.

Statement of the Case.

The patented inventions relate to steam generators for self-propelled or automobile torpedoes, that is, to the power plant by which the torpedo is propelled through the water on its errand of destruction. Prior to the inventions, the torpedo art had passed through certain stages of evolution to the point of producing a self-propelled torpedo which would travel through the water a distance of about

4,000 yards. But that range was distinctly deficient, because large Naval guns were accurate at two or three times that distance. For years the torpedo art sought the solution of this problem of range, but it remained unsolved until the present-day, long-range, 10,000 yard torpedo was produced by using the invention described and claimed in one of the patents covered by the license. That patent is No. 1,036,080 (Rec., pp. 25-31) granted to appellant as assignee of Gregory C. Davison on August 20, 1912, on an application filed by Mr. Davison on March 29, 1909.

The Davison patent discloses a special form of power plant for supplying motive fluid to the engine of a torpedo; that power plant is known as a steam generator because the motive fluid supplied by it consists largely of steam. A fuel, such as oil or alcohol, is burned at a high temperature in air or oxygen, and water is injected into the highly-heated products of this combustion to increase the volume of the motive fluid by vaporizing the water to form steam, and also to reduce the temperature of the hot products of combustion so that they may be introduced into the engine without danger of injury thereto.

In the power plants of the torpedoes in use at the time of Davison's work, fuel and air were burned and the hot products of this combustion formed the motive fluid; but such plants produced an insufficient amount of power, for the quantity of fuel that could be burned was limited by the temperature of the motive fluid which the engine would stand without injury. Such torpedoes were used to a considerable extent but their deficiencies were fully appreciated and they left the range problem an active issue confronting naval engineers.

Furthermore, prior to Davison's invention, suggestions had been made that water be introduced into the hot products of combustion to cool them and to generate steam; but none of these suggestions had materialized in a practical device with which relatively long range was actually obtained. The first torpedo mechanism practically adapted for the use of water to generate steam and drive a torpedo over a substantially increased range was that devised by Mr. Davison and disclosed in his patent.

The operation of such a steam generator requires the presence of air to maintain the combustion, of fuel to burn, and of water to be converted into steam. These three elements must be forced under pressure into the combustion chamber. The distinguishing and characteristic feature of Davison's invention which changed failure into success and disposed of the range problem for all time, is the idea of generating greatly increased power by admitting water to the hot products of combustion of air and fuel and automatically controlling the supply of fuel and water by the application thereto of the air pressure under which the air is fed into the generator, thus insuring that these three elements of the motive fluid will, under all circumstances, flow into the generator in correct relative proportions previously determined upon. This solution of the problem doubled the range of automobile torpedoes and brought them again to a parity of range with Naval guns.

Davison had been an officer of the United States Navy, and while he was engaged upon the development of the long range torpedo, he kept in touch with his former associates of the Navy and they were constantly informed of the progress of his work. The Navy Department itself undertook de-

velopment work upon a steam generator torpedo for increased range at the Naval Torpedo Station at Newport, Rhode Island; this experimentation extended over a period of many months but it failed to produce a successful form of steam generator and therefore the use of the water injection was abandoned.

Immediately thereafter, the Navy Department, through its torpedo officer, urged Mr. Davison to continue with his work on the development of the long-range steam-generator torpedo. Later a torpedo of the old type belonging to the United States Navy was delivered to appellant and was equipped with a steam generator under Mr. Davison's direction, and the complete success of the invention was demonstrated by a run of this torpedo of over 6,000 yards, that is, an increase of range of over 50% as a direct result of the application of the steam generator.

For many years the Navy Department had been having its torpedoes made by E. W. Bliss Company of Brooklyn and that Company's facilities for such manufacture were extensive. Some years after Davison's application for patent had been filed and after the experimental work at the Naval torpedo station above referred to, the Navy Department contracted with the Bliss Company for the manufacture of one experimental torpedo specially designed to develop long range. That torpedo was completed in the fall of 1911; it was equipped with a steam generator embodying the principles worked out by Davison and covered by his pending application for the patent here in issue, and when it was subjected to test, it ran over a range of 10,000 yards. Thereupon, negotiations were opened between the Navy Department and this appellant for a license to the Department under the

patents to be issued to Davison on his applications then pending. The proposed license was the subject of discussion and correspondence in Naval circles, the more so because the officer in charge of the Newport Torpedo Station was opposed to entering into such a license and pointed out in substance that if the license were executed the Government would be forced to pay royalties on torpedoes of the type which the Bliss Company had made. The Naval officials at Washington replied to this objection that the Davison inventions were patented and proceeded with the negotiation of the license agreement. Such suggestions as appellant made with respect to the agreement were promptly adopted; in particular, the Navy Department stated in a letter to appellant that the license covered by the agreement to be prepared would cover all of the old superheater torpedoes which would be converted to steam generator torpedoes, but appellant immediately replied that it understood the license would apply "also to torpedoes which the Government may build at its own works and in which the device in question is to be used." Immediately thereafter, the agreement was drawn up by the Department and so worded as to cover all torpedoes embodying the inventions described and claimed in the patents to be issued on the Davison applications. The Navy Department officials had quite definitely in mind that the license covered the long range torpedo of the Bliss Company and immediately on concluding the negotiation of the license, an order for a supply of those torpedoes was awarded to the Bliss Company.

It is with respect to those torpedoes supplied by the Bliss Company on that order and other similar ones supplied on subsequent orders that this appli-

cant seeks to recover the agreed royalty provided for in the license.

In the Court of Claims no question was raised as to the validity of the Davison patent or the existence of the license agreement; and the construction of the Bliss torpedoes was established by drawings provided by the defendant.

After argument at final hearing upon this testimony, the Court of Claims filed tentative findings of fact sustaining plaintiff's claim and set the case down for further argument on those tentative findings. After this second argument, the tentative findings, changed in some small respects but not in substance, were adopted as definite and the Court recorded its "conclusion of law" that "the plaintiff is entitled to recover." At the same time, the Court filed an opinion in which the plaintiff's position is stated and upheld with a clarity and force with which the Court's subsequent contrary decision makes a strange contrast. This first opinion is printed as an appendix hereto (*post,* p. 99).

Thereafter a motion to reopen for further testimony was submitted by the defendant, and after argument thereof, the Court withdrew its opinion, its findings of fact and its conclusion of law, and filed an order permitting defendant to take further testimony. Further testimony was taken and the case came again before the Court for argument. At this argument, defendant took the position that the license, which by its terms includes "torpedoes equipped with steam generator for automobile torpedoes covered by" the patent and patent applications listed in the license, should be limited to a specific construction of steam generator shown in a drawing sent by plaintiff to the Navy Department in connection with certain work which plaintiff

was doing for the Department under another contract.

Following this argument, the Court filed another set of findings of fact quite different from those originally filed, a "conclusion of law" that "the plaintiff is not entitled to recover" and a *per curiam* opinion of 21 lines (Rec., p. 23).

This final opinion of the Court of Claims is such that it is difficult to state the reasons for the Court's conclusion that "thé plaintiff is not entitled to recover." It is clear that the Court did *not* decide against plaintiff on the one and only ground urged by counsel for defendant at the last argument before the Court of Claims, namely, limitation of the license to the construction shown in a particular drawing. No mention was made of this contention of the defendant in the opinion and the drawing which was said by defendant to illustrate the construction to which defendant argued the contract was limited was not made a part of, and was not referred to in, the Findings of Fact.

We judge that the Court concluded that certain differences which exist between the torpedo manufactured for and used by defendant and the torpedo illustrated and described in the patent in suit are of sufficient consequence to justify a conclusion that defendant's construction does not fall within the scope of the patent, for the Court said in the opinion (Rec., p. 23) that "the question resolves itself into whether the Government used the plaintiff's device or something covered by one of the claims of its patents." We maintain that the Court erred in its conclusion that "the plaintiff is not entitled to recover" and ask the judgment of this Court thereon.

As stated above, no question is presented as to the execution of the license agreement, or the

grant of the patent relied upon, or the manufacture and use of the torpedoes on which royalty is claimed, or the specific construction and operation of those torpedoes. A single question is presented, namely, whether or not the torpedoes so constructed are within the patent and therefore within the license and subject to the royalty payment provided for therein.

That there are some differences of minor consequence between appellee's torpedo and that of appellant's patent, is not denied. We maintain that those differences are due to refinements developed by the patentee to secure further desirable results which in practical operation appellee has preferred to dispense with in order to secure greater simplicity; but that the omission of these refinements does not differentiate appellee's construction or method of operation from the patented one, or establish that the inventive idea originated by the patentee is not utilized. On the contrary, we maintain that appellee's construction and the patented construction are essentially the same, that appellee's construction is a full and complete embodiment of the idea of means disclosed in the patent, that the patent claims are as applicable to appellee's construction as they are to that illustrated in the patent, and that the specific object of the patentee in making the patented invention, namely, increasing the range of automobile torpedoes, is attained with appellee's construction to the remarkable extent of more than doubling the range of that type which immediately preceded the one on which the royalty is claimed. This remarkable result is attained by appellee *solely because of its use of the precise invention disclosed in appellant's patent and clearly defined in the claims of the patent relied on in this suit as the invention sought to be protected.*

Evolution of the Automobile Torpedo.

The apparatus involved in this suit is usually designated as a Steam Generator for Automobile Torpedoes. It is the power plant which is installed in a torpedo to supply motive fluid to the engine which drives the propellers of the torpedo. The engine may be either a reciprocating engine or a turbine, and in either case it is connected to two propellers at the stern of the torpedo, rotating in opposite directions about the same axis, to propel the torpedo through the water. Such a torpedo is commonly provided with two rudders, one vertical and the other horizontal; the vertical rudder is operated automatically by a gyroscope to steer the torpedo on a straight course, and the horizontal rudder is operated by automatic mechanism controlled by the pressure of the surrounding water to maintain the torpedo at a predetermined depth below the surface of the water throughout its run.

The self-propelled or automobile torpedo dates from about 1878. In nearly all forms that have gone into practical use, the propelling medium has been compressed air. The construction employed has always included a cigar-shaped shell divided by interior partitions to form a chamber at the bow for the explosive, next back of this a chamber for the storage of compressed air, and back of this a chamber for the propelling engine and the mechanism associated therewith, the engine being connected to two concentric shafts extending back through the aft end of the shell and carrying the propellers.

The air stored in the compressed air chamber may be compressed to as high a pressure as 2250 pounds per square inch. In the pipe leading from

the chamber back to the engine, a reducing valve is installed for reducing the air pressure to about 300 pounds so that air is admitted to the engine at a uniform pressure of 300 pounds throughout the run of the torpedo, although throughout that time the pressure in the storage chamber would be falling steadily from the initial pressure of 2250 pounds down to a final pressure of about 300 pounds. Torpedoes of this simple form were used extensively up to about fifteen years ago but their range, that is, the distance such a torpedo would be propelled by the charge of compressed air it is capable of carrying, is exceedingly small when measured by the standard of present-day practice. (Rec., p. 9, Finding IV).

As improvements were made year after year in naval guns, increasing the range at which they were effective, it became essential to increase the range of torpedoes to make them serviceable. In fact, the entire history of the automobile torpedo art is a record of effort to extend the range (Rec., p. 10, Finding V).

About 1901, a step toward this very desirable end was taken by heating the air in the compressed air storage chamber to give it greater expansive power, and this practice soon crystallized in the use of what has since become known as the "inside superheater." This consists of a burner *located inside the compressed air storage reservoir* and supplied with alcohol or other hydro-carbon, which is ignited as the torpodo is launched and burns throughout the run to heat the air within the storage chamber and thus hold its pressure more nearly up to the original storage pressure while air is being drawn from the chamber during the run. This inside superheater proved to be dangerous and far from satisfactory, but it was used

to a considerable extent and it did increase the range materially. Its use covered the period up to about 1908 and the range attained with it ran as high as 3000 yards. (Rec., p. 9, Finding IV.)

With further improvements in naval gunnery, a further increase in the range of torpedoes became highly desirable, and when the deficiencies and limitations of the inside superheater were fully realized, it gave way to what has become known as the "outside superheater." This consists of a chamber or enlargement in the air pipe carrying air from the storage reservoir to the engine, and devices for admitting liquid fuel, such as alcohol or gasoline, to this chamber at a uniform rate throughout the run of the torpedo; the fuel is sprayed into the chamber and mixed with the air therein, forming a combustible mixture which is ignited at the beginning of the run of the torpedo. Thus, throughout the run, combustion takes place in the chamber and the air passing therethrough to the engine is heated and its expansive force increased prior to its admission to the engine.

The outside superheater was a great improvement over the prior inside superheater and this led to its adoption by the United States Navy in 1909. It was much more safe and much more reliable, and with it an increase of range was attained. The range of torpedoes so equipped was about 4000 yards (Rec., p. 9, Finding IV).

But that range was far below what was desired and it could not be extended. The possibilities of the outside superheater were limited by the requirement that the air passing through the superheater on its way to the propelling engine must not be heated above a certain predetermined tem-

perature, since otherwise it would injure the mechanism of the engine.

This limiting temperature was such that only a small fraction of the oxygen in the stored air was used for combination with the fuel to form the combustible mixture which was burned in the superheater. All of the rest of the oxygen in this air was available for combustion, but it could not be utilized for that purpose because then the temperature would be so high as to melt the metal of the engine.

As stated above, the range attained with the outside superheater was insufficient; naval guns of that day were accurate at distances of two or more times 4000 yards. This condition was so serious that naval tacticians of 1908 and 1909 considered the automobile torpedo a very inferior weapon, of very limited utility. Battleships were equipped with such torpedoes, but they were thought to be of secondary value, useful only in event of encounters between fleets which would bring vessels of opposing sides in close proximity. On torpedo-boats or destroyers, torpedoes were to be used only in a night attack or in a fog, for in daylight a torpedo-boat would easily be destroyed by the guns of a hostile ship before it could approach to a point at which a torpedo could be launched with any hope of having it reach its mark.

This was the condition of the automobile torpedo art at the time when Gregory C. Davison made the invention covered by Patent 1,036,080, under which the appellee is licensed.

The Davison Invention.

Mr. Davison's intensive study of the subject led him not only to a clear appreciation of the above-mentioned limitations of the outside superheater, but also to a full realization of the fact that the energy available to propel a torpedo could be enormously increased by developing as much heat as possible in the combustion of *all* the oxygen in the air and a relatively large quantity of fuel, and introducing into the intensely hot products of combustion a sufficient quantity of water to be converted into steam, thereby absorbing heat from and thus cooling the gases of combustion and producing a large volume of steam.

He proposed to change the combustion chamber of the outside superheater in which only a small fraction of the oxygen entered into combustion with the fuel, into a steam generator in which all or substantially all of the oxygen of the air, or even the increased oxygen supply of an enriched oxygen-carrier, was made use of to produce the new motive fluid. He considered the compressed air not merely in its dynamic sense as a motive fluid, but also in its chemical sense as a carrier of oxygen and he referred to it as an "oxygen-carrier" throughout his patent. This state of mind may be looked upon as the cultural medium in which the invention was developed.

Davison proposed that *all of the oxygen in the compressed air* be utilized in combination with the fuel, thereby making it possible to burn a far greater amount of fuel and thus develop a far greater amount of heat; and *this heat he proposed to utilize in vaporizing water,* thereby producing a motive fluid consisting of a mixture of steam and

the hot gases of combustion, which fluid would have great volume because of the steam contained in it and would be at a temperature suitable for admission to the engine because the great heat developed by the combustion, which would otherwise destroy the metal parts of the engine, would be absorbed in vaporizing the water.

As in the case of other inventions, it was necessary for Davison to couple with this idea of purpose or end to be achieved, a practical idea of means so well adapted to the peculiar conditions under which the steam generator was to operate in an automobile torpedo as to result in a completed operative device suitable for practical use and actually available in tangible form to produce the desired increase in range.

Davison's first attempt was an abortive one; it is represented in his patent No. 1,036,082, for which he made application on March 19, 1908 (Ex. C-15, Rec., pp. 135-144). At first he did not appreciate the possibility and advantage of injecting the water directly into the combustion chamber, nor had he conceived the idea of establishing and maintaining a correctly regulated flow of fuel and water by *utilizing the pressure of the air and hence its rate of flow into the generator chamber as a regulator* to govern the rate of flow of the fuel and water into that chamber.

Subsequently, in the summer and fall of 1908, Mr. Davison proceeded with the development work and produced the arrangement of his patent No. 1,036,080, here in suit.

In this arrangement, as in the preceding one, Davison provided for the admission of water and fuel to the generator chamber; but there was this distinguishing difference, that an *automatic regula-*

tion was provided for the rate of flow of the air, fuel and water into the generator chamber whereby these three ingredients would enter the chamber always in the proper proportions. Any variation in the rate of flow of the air from the supply chamber to the generator chamber would be accompanied by an immediate and corresponding variation in the rate of flow of the water and fuel. Thus there could be no excess of fuel or deficiency of water, either of which would result in the production of motive fluid at such a high temperature as would melt the metal of the engine, and there could be no excess of water or deficiency of fuel, either of which would cause a great loss of efficiency. All three ingredients used in the generator chamber to form the motive fluid entered into the chamber always in the proper proportions and always under automatic and immediate control obtained by making the rate of flow of the fuel and water dependent upon the rate of flow of the air. This is a distinguishing characteristic of the Davison invention; without it the Davison invention is not utilized and the presence of this automatic regulation is a fairly conclusive indication that the Davison invention is utilized.

The special object that Davison had in view was increasing the range of automobile torpedoes and he demonstrated that his invention was effective in attaining that object. He obtained from the Navy one of the old torpedoes of the outside superheater type and substituted his steam generator in it and *the torpedo whose range had previously been 4000 yards ran over 6000 yards* (Finding XI, Rec., pp. 20-21); and had the engine and the other parts of the torpedo been in good condition, instead of

being badly worn, the run would have been much greater.

The Davison patent should now be considered, but, preliminary thereto, it would be well to consider briefly two of the prior art patents which represent stages in the evolution of the modern torpedo prior to the Davison invention.

The figure at the top of the sheet opposite page 18 illustrates the simple form of automobile torpedo driven by compressed air, as used in the navies of the larger nations up to about 1900.

The torpedo is cigar-shaped as usual and at its forward end is a chamber A in which the explosive is carried. Directly back of this is a chamber B for the storage of the compressed air whose initial pressure may be as high as 2250 pounds per square inch. At the aft end of the torpedo, back of the air chamber, is a chamber for the steering gear, the depth regulating gear, the engine and the associated parts. The engine is indicated at C; it may be a turbine or a reciprocating engine. In either case, it is connected to two concentric shafts carrying the two propellers at their rear ends. The compressed air flows from the chamber B to the engine C through a pipe D as indicated, and in this pipe is a reducing valve E which operates automatically to reduce the pressure of the air from the high and steadily declining pressure existing in the chamber B to a lower and constant pressure of say 300 pounds, at which the air is utilized by the engine. This represents the simple form of cold, compressed-air torpedo mechanism which was in general use up to about 1900 (Rec., p. 9, Finding IV).

In the evolution of the modern construction, this cold air type was succeeded by the inside super-

heater type disclosed in the Leavitt patents, Exhibits C-2 and C-3. The second figure on the accompanying sheet is a reproduction of Fig. 1 of the Leavitt patent No. 693,872, Exhibit C-3, Rec., fol. pp. 60-66).

This is like the cold air construction illustrated above except that the superheater has been added. Within the chamber B for the storage of compressed air is a burner F which is supplied with alcohol or other liquid fuel from a tank G by means of a pipe H. The alcohol is ignited automatically at the beginning of a run of the torpedo, and throughout the run, the alcohol is supplied to the burner at a rate which is governed by the pressure of the air existing within the chamber B. In this way, the air utilized for driving the propelling engine is heated prior to being utilized so as to increase its pressure, this air flowing, as before, through the pipe D and reducing valve E to the engine C. Aside from the danger incident to the use of this inside superheater, its primary deficiency from an operating standpoint resides in the limitation, inherent in its structure, to a relatively small use of the energy of combustion. In no event can the heat of combustion be utilized in sufficient degree to increase the pressure in the air flask above the initial pressure, for then it might burst the torpedo shell. This inside superheater construction was utilized by the United States Navy between the years 1901 and 1909 (Rec., p. 9, Finding IV.)

In 1908, the Navy adopted the outside superheater which is represented by the Sodeau British patent No. 15997 of 1906, Exhibit C-8.

The third sketch on the accompanying sheet shows the torpedo of the Leavitt patent illustrated

above, having the inside superheater removed and the outside superheater of the Sodeau British patent installed.

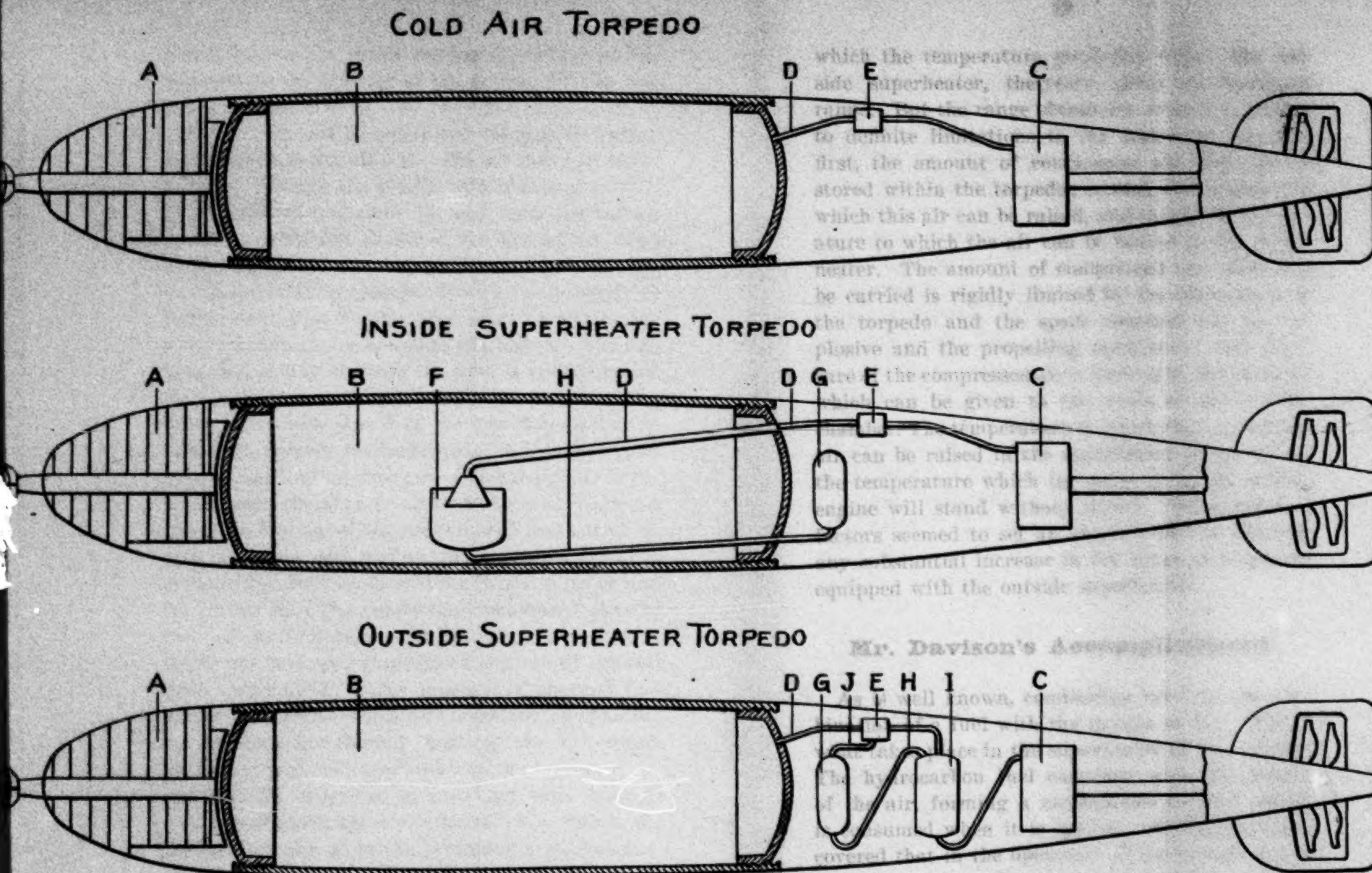
First, it should be noted that there is no burner within the air chamber B. The air flows from the chamber through the pipe D and reducing valve E to a combustion chamber I; and from the bottom of this combustion chamber, the heated air flows to the engine C. Alcohol or other fuel is supplied to the combustion chamber from a container G by means of a pipe H; this pipe leads to a spraying nozzle within the combustion chamber I. The fuel is caused to flow through the pipe H and its nozzle by compressed air which passes from the reducing valve E through pipe J to the top of container G. When the torpedo is discharged, the reducing valve E is opened and air flows through the pipe D to the combustion chamber I; also, air flows through the pipe J to the top of the container G and exerts its pressure upon the fuel in the container, thereby causing the fuel to flow through the pipe H and its nozzle into the combustion chamber. As the flow of the fuel begins, an igniter is actuated to ignite the fuel, and throughout the run of the torpedo, combustion of the mixture of sprayed fuel and air takes place within the combustion chamber or superheater, thereby heating the air which passes through the superheater to the engine.

It will be recognized at once that with this outside superheater, the air is heated, not within the air-storage tank as in the preceding type, but during the passage of the air from that tank to the engine. With the outside superheater, the temperature desired for the air admitted to the engine is maintained practically constant throughout the run, as compared with the inside superheater in

which the temperature gradually falls. [illegible] side superheater, therefore, gives [illegible] range. But the range obtainable with [illegible] to definite limitations in the following [illegible] first, the amount of compressed air [illegible] stored within the torpedo; second, the pressure [illegible] which this air can be raised, and third, the [illegible] ture to which the air can be heated in the [illegible] heater. The amount of compressed air which [illegible] be carried is rigidly limited by the dimensions [illegible] the torpedo and the space required for [illegible] plosive and the propelling machinery. The [illegible] sure of the compressed air is limited by the [illegible] which can be given to the walls of the [illegible] chamber. The temperature to which the [illegible] air can be raised in the superheater is [illegible] the temperature which the parts of the [illegible] engine will stand without injury. These [illegible] factors seemed to set an absolute bar to [illegible] any substantial increase in the range of [illegible] equipped with the outside superheater.

Mr. Davison's Accomplishment

As is well known, combustion involves [illegible] bination of a fuel with the oxygen of air. [illegible] that takes place in the superheater of [illegible] the hydrocarbon fuel combines with the oxygen of the air, forming a combustible mixture [illegible] is consumed when it is ignited. Mr. Davison [illegible] covered that in the operation of the outside [illegible] heater torpedo, only a small fraction of [illegible] gen in the air admitted to the superheater [illegible] combined with the fuel and consumed. [illegible] were admitted at a higher rate, to [illegible]


COLD AIR TORPEDO
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INSIDE SUPERHEATER TORPEDO
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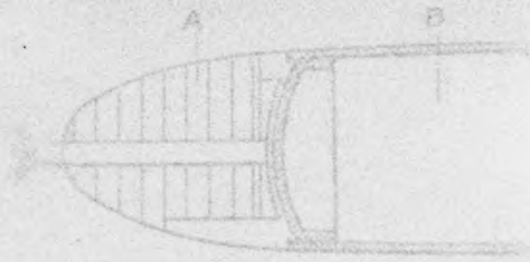

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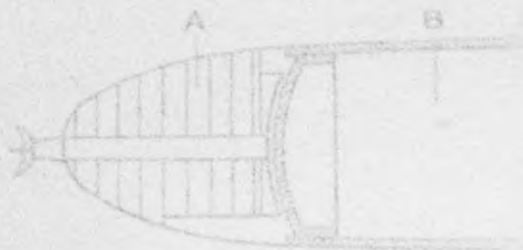
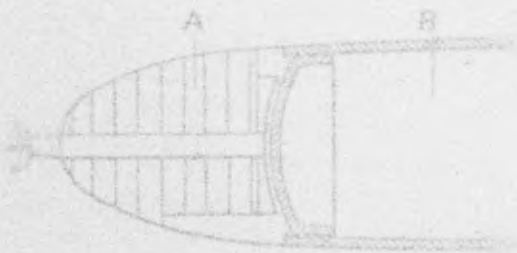


OUT



which the temperature gradually falls. The outside superheater, therefore, gives an increased range. But the range obtainable with it is subject to definite limitations in the following respects: first, the amount of compressed air that can be stored within the torpedo; second, the pressure to which this air can be raised, and third, the temperature to which the air can be heated in the superheater. The amount of compressed air which can be carried is rigidly limited by the dimensions of the torpedo and the space required for the explosive and the propelling machinery. The pressure of the compressed air is limited by the strength which can be given to the walls of the storage chamber. The temperature to which the compressed air can be raised in the superheater is limited by the temperature which the parts of the propelling engine will stand without injury. These limiting factors seemed to set an absolute bar to effecting any substantial increase in the range of torpedoes equipped with the outside superheater.

Mr. Davison's Accomplishment.

As is well known, combustion involves the combination of a fuel with the oxygen of air. This is what takes place in the superheater of the torpedo. The hydrocarbon fuel combines with the oxygen of the air, forming a combustible mixture which is consumed when it is ignited. Mr. Davison discovered that in the operation of the outside superheater torpedo, only a small fraction of the oxygen in the air admitted to the superheater was combined with the fuel and consumed; if the fuel were admitted at a higher rate, to supply enough

fuel for combination with all or a large proportion of the oxygen in the air admitted to the superheater, then the temperature of the products of combustion passing from the superheater to the engine would be so high as to melt the metal of the engine. Thus, the temperature which the engine would stand without injury made it essential that the fuel be supplied to the superheater at such a low rate as would result in utilizing for combustion only a small fraction of the oxygen in the air admitted to the superheater. Mr. Davison reasoned from this that if something could be done to permit of utilizing all of the oxygen in the air for combustion without developing too high a temperature, a motive fluid of greater expansive power would be developed and the range of the torpedo would be correspondingly increased. How to do this was the problem which confronted him, and he solved it by providing for the admission of water to the combustion chamber which water would be heated by the hot products of the combustion of the fuel and air, thereby vaporizing the water to form steam whose expansive power would be equal to that of the hot products of combustion and whose temperature would be low enough to permit of admitting it to the engine with entire safety. His conception went even further; it contemplated not only the possibility of using all the oxygen in the air for combination with the fuel, but also the enrichment of the air admitted to the combustion chamber by increasing its proportion of oxygen so that there would be an even greater amount of oxygen present for combination with the fuel. As is well known, atmospheric air contains less than 25 per cent of oxygen, the remainder being nitrogen which does not enter into combustion

and Mr. Davison's conception involved the use of air enriched to contain far more than 25% of oxygen or even pure oxygen.

In this way, Mr. Davison swept aside completely the barrier formed by what seemed to be absolute limitations upon the range possibilities of the air-driven torpedo. Where it had been considered impossible to use more than a small fraction of the oxygen in the air for combustion, for fear of burning up the engine, he made it possible to use all of the oxygen in the air and even to put more oxygen into the air and use that. He transformed the old outside superheater, such as that described in the Sodeau British patent, into a steam generator. The product issuing from this generator and passing to the engine, instead of being heated air, is a mixture of steam and the gases of combustion, and even though fuel be burned in such quantity as to consume all of the oxygen in the air admitted to the generator chamber, still the product passing from the chamber to the engine is at such a relatively low temperature as to eliminate the possibility of injury to the engine. Mr. Davison's steam generator is similar in its general structural features to the outside superheater previously used and fuel is admitted to it and burned in it as had been done in the outside superheater. But in addition to the fuel spray, provision is made for spraying water into the hot products of the combustion taking place within the chamber, whereby those products are cooled down to a safe temperature and steam is generated to supply the desired motive fluid.

Furthermore, Mr. Davison's invention included a simple and practical means for attaining an essential attribute of success in the practical application

of the steam generator to torpedo propulsion, namely, the admission of the air, fuel and water to the steam generator *in definite proportions.* An excess of air would result in decreased efficiency; an excess of fuel would result in waste and either dangerously high temperature or the flow of liquid fuel into the engine; and an excess of water would result in water passing into the engine and might even cause discontinuance of the combustion. So Davison provided means for insuring the maintenance of the proportions of air, fuel and water which were found by calculation and experiment to be conducive of the best results, *by making the feed of the fuel and water into the steam generator depend upon the pressure of the air, and hence upon the rate of flow of air into the generator.*

That Mr. Davison's achievement constituted an invention of high order is shown in most convincing manner by established facts. Extending the range of automobile torpedoes had been a problem confronting the Navy for years, in fact, throughout the history of the torpedo (Finding V, Rec., p. 10). But since the use of torpedoes of the steam generator type embodying the Davison invention, this problem has been completely solved. Any greater range than that attainable with the steam generator torpedo is not desired, for accuracy in the operation of the steering gear cannot be attained at distances beyond the torpedo's present range.

Considered broadly, the Davison achievement was the elimination of the problem of range in torpedo manufacture. Considered more specifically, three facts stand out pre-eminently on the record before the Court as tributes to the Davison invention.

First, Mr. Davison applied his steam generator to an existing torpedo of the type using the outside superheater, and when the torpedo so modified was tried on a test run, it covered a range of over 6,000 yards, whereas its range before being equipped with the steam generator was only 4,000 yards (Finding XI, p. 21).

Second, a torpedo made by the Bliss Company, equipped with the steam generator and embodying the invention of the Davison patent, attained a range of 10,000 yards at 26 knots per hour (Finding VIII, p. 14); and the torpedoes of the steam generator type which the United States Navy has been using since then have a range of double that of the outside superheater type which was superseded by the steam generator type (Finding IV, p. 9).

Third, beginning about a year after Mr. Davison's work, the torpedo station of the United States Navy at Newport endeavored to solve the range problem by developing a steam generator. After experimentation extending over a period of more than eight months, the torpedo station reported that though "several methods of vaporizing the liquid have been experimented with," still "the best method of introducing the water has yet to be ascertained." So, after all of this concentrated effort of the Newport Torpedo Station upon solving the range problem by the use of the steam generator, the station was forced to admit that it had not yet been able to find the best method of introducing the water; and because of that, it was decided that in further work alcohol would be used as a fuel and there would be "no injection of water" or generation of steam (Finding V, pp. 10-11).

The Davison Patent.

With this preliminary explanation, the Davison patent should be readily understood. The introductory paragraph of the specification covers, in condensed form, the explanation above given. It reads as follows (Rec., p. 25):

> "In the operation of automobile (or self-propelled) torpedoes, it would be of great advantage to substitute for the compressed air commonly used as a motive fluid, a motive fluid derived by burning a suitable fuel with compressed air or oxygen and then injecting into the highly heated products of combustion a quantity of water, whereby the water is converted into steam, adding to the volume of the fluid and reducing its temperature. In this way there may be formed a motive fluid under extremely high pressure and at moderate temperature, which is admirably adapted to the operation of the light, high-speed, powerful engines which are used on such torpedoes; and a very high degree of efficiency of energy transformation may be secured; *provided an apparatus can be devised which is of the requisite simplicity in construction and regulation, so that it may be used without danger and with the assurance that it will be in operative condition whenever it may be called upon to do its work*" (Italics ours).

Following this is the usual detailed description of one construction in which the invention may be embodied. The drawings illustrating this construction show an arrangement suitable for actual use. This construction may be illustrated diagram-

matically to facilitate explanation of it, as it is at the top of the sheet opposite page 36, to which reference will now be made.

CONSTRUCTION.

This sketch shows the usual chamber *a* for storing compressed air and the air flows from the chamber through a pipe *c*, reducing valve *d* and pipe *e* to the generator chamber *f* and from this chamber *f* the motive fluid flows by pipe *g* to the engine *s*, in substantially the same manner as in the outside superheater type of torpedo. The fuel is supplied to the generator from a container *b* through a pipe *y*, also as in the outside superheater type.

In supplying water to the generator, Davison decided to draw the water from the sea in which the torpedo is immersed rather than carry the supply of water within the torpedo; this saved much of the space required for the water tank and guarded against change of balance of the torpedo as the water supply was consumed. Of course it makes no difference where the water comes from; it may, to equal advantage, be stored in the torpedo or introduced from any available outside source. But as Davison decided to draw it from the sea, he provided a pump as shown at *t* connected to the exterior of the torpedo by a pipe t^1.

As already stated, it is of the utmost importance that the supply of the water and the fuel to the generator shall be under the control of and therefore proportionate to the air flowing to the generator. It is immaterial to the invention how this is done, the claims only requiring that it shall be done in some way. Davison's specific way was to provide a regulator as shown at *u*, connected to the pump *t* by a pipe *x* so as to receive water from

the pump. From this regulator, the water flows by a pipe k to the generator chamber f. Also the water flows from the regulator by pipe t^2 to the bottom of the container b for the fuel so as to force the fuel out through pipe y.

The inlet for water from the pump t to the regulator u through the pipe x is controlled by a valve indicated at w, actuated by a rubber diaphragm u^1 in the regulator and the space at the top of the regulator above the diaphragm is connected to the air pipe e by means of a branch pipe e^1. Thus this valve is controlled by the joint action of the air pressure entering the top of the regulator through pipe e^1 and the water entering the bottom of the regulator through pipe x from pump t.

It is in this way that the pressure of the air flowing to the generator chamber, and hence the rate of flow of that air, regulates the rate of flow of the fuel and water to the generator chamber. The air pressure governs the extent of the opening of the inlet to the regulator u and hence the freedom of flow of water from the pump t into the regulator. Part of this water flows from the regulator directly into the generator by pipe k and part of it flows by pipe t^2 into container b and thus forces the fuel out of the container and by pipe y into the generator. Thus the air, fuel and water flow into the generator chamber under a common control and therefore these three ingredients of the motive fluid will always be supplied in fixed proportions.

Within the generator chamber, the fuel is ignited and burns in combination with the oxygen of the air, and water is sprayed into the hot prducts of the combustion, vaporizing the water to form steam and reducing the temperature to within workable limits, and the steam so generated forms part of the

motive fluid which flows through pipe *g* to the engine *s*.

The three figures at the bottom of the sketch sheet opposite page 36 are reproductions of the drawings of the Davison patent and show the apparatus as designed for construction. At the left of Fig. 1 is the rear end of the storage chamber *a* for compressed air. Immediately back of this is a chamber for fuel formed by the partition *b*. A pipe *c* extending through the fuel tank carries the air back to the reducing valve *d* and then the air flows by pipe *e* to the generator chamber *f*. From the bottom of this generator chamber *f*, a pipe *g* carries the motive fluid to the propelling engine *s* at the extreme rear.

Next in front of this engine is the pump *t* which draws water from the sea through the connection t^1, at the base of the pump. The water drawn in from the sea through this connection is forced out by the pump through a connection *x* by which the water flows to the regulator *u*. One of the water connections leading from this regulator is indicated at *k*; it extends to the top of the generator chamber *f*. The other water connection from the bottom of the regulator *u* is a pipe t^2 which extends through the partition *b* to a point near the bottom of the fuel chamber and the water admitted to the fuel chamber through this pipe connection forces the alcohol or oil, which is lighter than the water, up and out through pipe *y*. This pipe is shown as extending into the top of the generator chamber *f*.

One further pipe connection is to be noted. It is the pipe e^1 extending from the air pipe *e* to the top of the regulator *u*.

Fig. 2 is a longitudinal section of the generator chamber. At the center of the top is a connection including three concentric tubes *n*, *m* and *i*, through

which the fuel, air and water are admitted to the generator. Inside the generator is a hood *o*. The fuel is sprayed into the space within this hood by the nozzle n^1 and the air flows in around this spraying nozzle. The water is admitted through the pipe *k*, sleeve *i* and radial openings *l* above the hood *o* and it flows down over the hood, being heated meanwhile, and as it does not come into contact with the fuel until combustion is complete, there is no danger of the water extinguishing the flame. The parts shown at the left of the spraying nozzle just described constitute an igniter which is operated automatically to ignite the mixture of fuel and air. At starting, the first operation is to open the air connection from the storage chamber through the reducing valve to the generator and the pressure of the air so admitted to the generator chamber actuates the igniter. The flow of fuel into the chamber follows almost immediately thereafter and then ignition takes place.

The regulator heretofore referred to, by which the feed of the water and fuel into the generator chamber is placed under the control of the air and is therefore made proportionate to the flow of air into the generator chamber, is shown in section in Fig 3. An elastic diaphragm is indicated at u^1 and the space above this diaphragm receives the air from the main air conduit through the branch pipe e^1. The space below the diaphragm is filled with water entering the regulator by the pipe *x* leading from the pump. The water flows out from the regulator through the pipes *k* and t^2, the pipe *k* leading to the generator chamber, and the pipe t^2, leading to the fuel tank. The pressures of the air and water act on opposite sides of the diaphragm u^1 and thus serve to position it. This diaphragm is secured to a rod *r* which is connected by a lever to a valve *w*

controlling the entrance of water from the pipe *x* to the interior of the regulator. When the air pressure preponderates, diaphragm u^1 and rod *r* are moved downwardly and the valve *w* is opened somewhat, allowing water to enter more freely and increasing the pressure on the lower side of the diaphragm u^1. This tends to move the diaphragm upwardly and close the valve *w* somewhat. In this way, the pressures of the water and air on opposite sides of the diaphragm u^1 act constantly throughout the run of the torpedo to effect automatic regulation of the position of the valve *w*, and as a result, the rate of flow of water through the regulator and the pipes t^2 and *k*. Therefore, the rate of flow of water and fuel into the generator chamber is at all times dependent upon the air pressure in the pipe *e* and hence upon the rate of flow of air into the generator chamber.

Operation.

The operation of the mechanism thus described may be summarized by reference to either the simplified drawing or Fig. 1 of the drawings of the patent.

When the torpedo is launched, the starting lever is actuated to release the reducing valve *d* and air flows from the compressed air storage chamber *a* through the pipe *c* to the reducing valve. This air is at very high pressure but the reducing valve operates automatically to allow air to pass therefrom at a substantially uniform pressure. The air passes through the pipe *e* into the generator chamber, and then through the pipe *g* to the propelling engine *s* to operate that engine initially as a cold compressed air engine. Air from the generator *f* also passes through a branch pipe *h* (not shown on

the simplified sketch) to the power cylinders of the pump t and this pump is likewise started in operation. Air from the pipe e also passes through the pipe e^1 to the upper chamber of the regulator and its pressure is exerted upon the flexible diaphragm u^1 to move that diaphragm and its attached rod r downwardly and thus open the valve w. When the pump t is started in operation, it forces water through pipe x and into the regulator u through the open valve w. After the regulator has been filled, water passes through the pipe t^2 into the bottom of the fuel chamber and serves to force the liquid fuel in that chamber through the pipe y into the top of the generator through the spraying nozzle n^1, and the fuel issuing from this spraying nozzle is mixed with the air entering the chamber around the nozzle to form the combustible mixture. Also the air admitted to the generator chamber actuates the fuse q and causes it to ignite and the fuse burns for several seconds so as to insure ignition of the fuel when admission of the fuel to the generator chamber begins. The combustion of the fuel admitted through the spray nozzle n^1 and the oxygen of the air admitted around the nozzle develops hot combustion products within the generator and heats hood o. Water forced into the regulator chamber u also passes out through the pipe k and enters the top of the generator chamber in a spray directed radially outward into the space between the hood o and the top of the generator. This water passing down over the hot hood in a spray and mingling with the hot products of combustion, is vaporized, and the steam thus generated flows out through the pipe g to the engine s to continue it in operation, and flows out through the pipe h to the pump t to continue its operation.

The summary of the operation of the mechanism appearing in the patent, reads as follows (Rec., p. 28):

"The operation of the system as a whole is as follows: When the torpedo is launched the valve *d* is opened automatically and the oxygen-carrier at the predetermined pressure is admitted to the upper portion of the generating chamber through the pipe *m*. The pressure thus produced in the generating chamber forces the fuse-carrier up the bore of receptacle *p* against the firing projection and ignites the fuse. The fuse contains a slow burning composition, preferably one which will burn for several seconds, and before it is burned out, the pump, actuated initially by the oxygen-carrier passing through pipe *h*, will force fuel through the nozzle *n* into the generator, there forming an explosive or combustible mixture which will be ignited by the fuse. At the same time, or substantially the same time, that the fuel is admitted, jets of water will be thrown with a circumferential or whirling motion from the sprayer head *l* into the space between the hood *o* and the body of the generator, and as the hood heats up and the hot products of combustion accumulate, the water will be vaporized and mixed with the products of combustion, but by reason of the interposition of the hood *o* the combustion will be complete before the mixture takes place so that the water cannot interfere with the combustion. The mixed products of combustion and water vapor in the lower portion of the generator pass through the pipe *g* to the engine and through the pipe *h* to the pump."

Two points of primary importance should be noted in the operation of this mechanism. First. there is no occasion for limiting the amount of fuel which may be admitted to the generator for combustion with the oxygen of the air to avoid danger of developing excessive temperatures which would injure the mechanism beyond the generator. Fuel may be admitted in such large quantity that all of the oxygen in the air admitted will be utilized in combining with the fuel to form a combustible mixture. It does not matter how high the temperature of the products of combustion may go; in fact, the higher it goes, the better. The reason for this is that the hot products are reduced in temperature by the water which is admitted, for this water absorbs heat from the combustion products and in doing so is vaporized, thereby producing steam which is equally available for the operation of the engine, which conserves the energy in the hot combustion products, and which is at such a temperature as to permit it to be introduced into the engine with entire safety.

The second point of primary importance is that the feed of the fuel and water to the generator is regulated in direct proportion to the rate of flow of air into the generator. This, in Davison's specific embodiment of his invention, is effected by the automatic regulator. The rate at which air enters the generator *f* is dependent upon the pressure of the air passing through the reducing valve and the pressure existing within the generator. The greater this difference of pressure, the higher will be the rate of flow of the air. The reducing valve *d* may be adjusted to regulate as desired the pressure of the air passing from the valve; in practice, it is common to so adjust the valve as to produce a pres-

sure of 350 pounds per square inch at this point (Rec., p. 31). The pressure existing within the generator *f* depends primarily upon the construction of the engine *s*; this pressure may be about 300 pounds. Under those conditions, there would be a difference of pressure of 50 pounds tending to cause the flow of air through the pipe *e* and into the generator *f*. This difference of pressure may be caused by any restriction in the pipe *e*. Thus, in figure 2 of the drawings of the patent, the air passage is shown as restricted at the point where it passes between the tubes *m* and *n*, and this restriction occasions the drop of pressure of 50 pounds, just as contracting a rubber hose by pressing on opposite sides of it restricts the flow of water through the hose and reduces the pressure of the water beyond the restriction.

As long as these conditions prevail, namely, a pressure of 350 pounds in the air passing through the reducing valve, and a pressure of 300 pounds within the generator, air flows through the pipe *e* and into the generator at a definite and fixed rate corresponding to a pressure difference of 50 pounds. This same pressure of 350 pounds of the air passing through the reducing valve is exerted upon the upper surface of the flexible diaphragm u^1 of the regulator by reason of the open connection from the pipe *e* to the regulator through the pipe e^1. Also, this diaphragm, positioned by the air pressure exerted thereon, operates the valve *w* for throttling, more or less, the flow of water from the pump *t* through the pipe *x* into the regulator. *The pressure of the water in the regulator u must, therefore, bear a definite relation at all times to the pressure of the air in the pipe e, that is, the pressure of the air passing through the reducing valve.*

If the pressure of the water in regulator *u* rises, the flexible diaphragm u^1 moves upwardly and the valve *w* moves toward its closed position to restrict the freedom of flow of water from the pump into the regulator; on the other hand, if the pressure of the water in the regulator falls, the diaphragm u^1 moves downwardly under the air pressure and opens the valve *w* wider to increase the freedom of flow of water from the pump into the regulator.

Thus, this definite relation of the water pressure in the regulator to the air pressure in the pipe *e* is always maintained throughout the operation of the apparatus. And this pressure within the regulator *u* serves to force water through the pipe *k* and into the generator *f*. The rate of flow of water into the generator is, therefore, at all times dependent upon the difference between the pressure within the regulator *u* and the pressure within the generator *f*. But as the pressure of the water in the regulator *u* is dependent upon the pressure of the air in pipe *e*, the feed of the water into the generator is dependent upon the pressure of the air in pipe *e*, and must necessarily bear a definite relation to the rate of feed of air into the generator *f*. Likewise, the pressure of the water in regulator *u* is exerted through the pipe t_2 upon the fuel in the fuel reservoir, and causes the feed of the fuel through pipe *y* into the generator. Therefore, the feed of the fuel, being governed by the regulator *u*, must also be dependent upon the air pressure in pipe *e*, and must bear a definite relation to the rate of feed of air into the generator. This mechanism, therefore serves to regulate automatically the rate of feed of fuel and water into the generator, in direct relation to the rate at which air is supplied to the generator; in other words, these three ingre-

dients enter the generator in fixed proportions, and so long as the mechanism operates in the intended manner, no change in the rate of supply of any one of the ingredients to the generator can occur without a corresponding change in the rate of feed of the other two ingredients.

For instance, if faulty operation of the parts were to cause a cessation of the flow of air through the pipe *e* to the generator, the feed of water and fuel would cease at once, for the diaphragm u^1, relieved of air pressure on its upper surface, would move upwardly, with the result that the valve *w* would close entirely and the entrance of water into the regulator *u* would cease. Also, it will be noted that the feed of the fuel and water is effected by the same pump *t*. It follows that fuel cannot be forced into the generator unless water is also forced into the generator; this eliminates the possibility of developing a dangerously high temperature due to the combustion of fuel in the generator when no water is present to reduce the temperature of the combustion products and generate steam. Furthermore, as the fuel supply in the fuel chamber becomes diminished, its place is taken by water, thus avoiding the production of an air space adjacent to the fuel in which an explosive mixture might be formed. Lastly, it will be noted that if the supply of water to the generator ceases, the supply of fuel to the generator will also cease, and air flowing into the generator through the pipe *e* may pass on through the pipe *g* to the engine *s* to operate the engine as a cold, compressed air engine.

These characteristic features of the mechanism illustrated and described in the patent are pointed out on page 2 of the patent (Rec., p. 27), as follows:

"With this construction and arrangement of parts, the pressure of the oxygen-carrier in the pipe *e* on the low pressure side of the reducing valve *d* controls absolutely the pressure on the fuel and the pressure on the water supply to the generating chamber, so that the oxygen-carrier, the fuel and the water are fed always at a predetermined pressure to the generating chamber, and if, for any reason, the supply of oxygen-carrier is cut off or exhausted, the supply of fuel and water to the generating chamber will cease at once, while, as long as there is a supply of oxygen-carrier under pressure and the flow of water into the regulator chamber is not interrupted, the supply of fuel and water to the generating chamber will continue under proper control. Furthermore, by this arrangement the fuel in the fuel tank, as it is withdrawn, is replaced by water, which, of course, remains at the bottom of the tank. This prevents a possibility of the admission of air or oxygen into the fuel tank and the formation therein of an explosive mixture. But a single pump is necessary to feed both the fuel and the water and it is made certain that the fuel and the water will be fed under the same pressure and will both be controlled by the pressure of the oxygen-carrier. This dependence of the fuel supply upon the water supply, and their mutual dependence upon the single pump and the pressure of the oxygen-carrier, is of further advantage in that it is impossible that the water supply should be stopped and the fuel supply continued, thereby creating unduly high temperatures in the generating chamber and engine. Further-

more, it will be observed, the [illegible] is such, that if, for any reason such as the breaking down of the water pump, the flow of water into the regulator chamber is interrupted, the supply of fuel will immediately cease, thus bringing the combustion to an end and preventing unduly high temperatures. Nevertheless, the air or oxygen under pressure will continue to flow from the storage tank through the combustion chamber to the engine, and the torpedo will continue to be driven until the supply of oxygen-carrier under pressure is exhausted."

The Question Presented in This Suit.

The claims of the Davison patent relied on in this suit are those numbered 1, 5, and 13. Extended discussion of them at this point is unnecessary; it is sufficient to state that they are directed to the steam generator system which we have described in detail, wherein air, fuel and water are supplied to the generator chamber for combustion of the fuel and air and generation of steam from the water, and wherein the feed of the fuel and water depends at all times upon and is automatically regulated by the pressure of the air. These claims constitute a definition, in brief, of the accomplishment in the [illegible] torpedo [illegible] by Mr. Davison and described at length in the patent.

The sole question presented in this case is whether or not this [illegible] the automobile torpedoes made for the Navy Department. No [illegible]

DAVISON STEAM GENERATOR TORPEDO

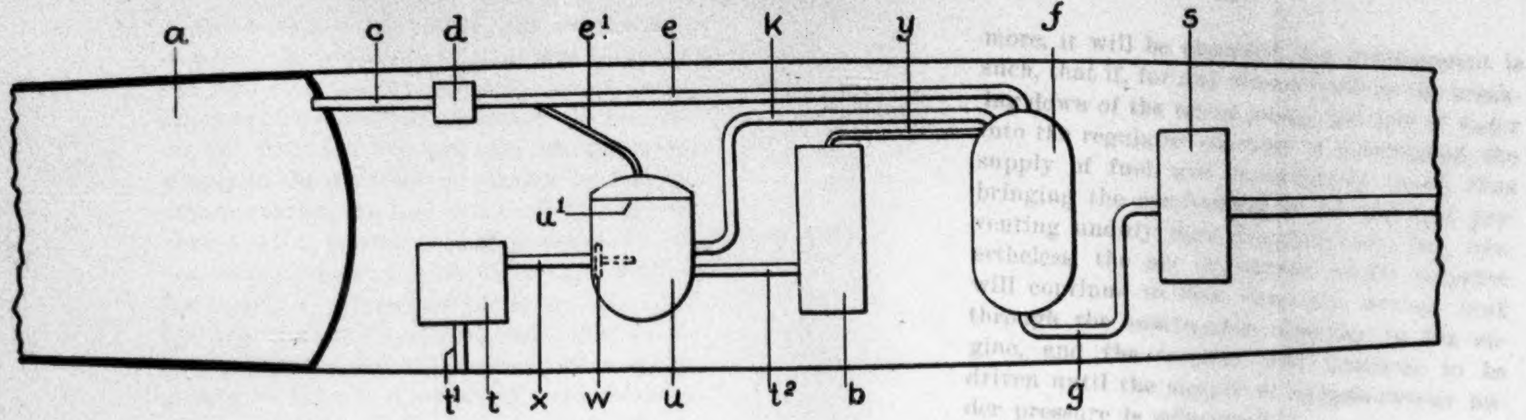


FIG. 2.

DAVISON PATENT

FIG. 1

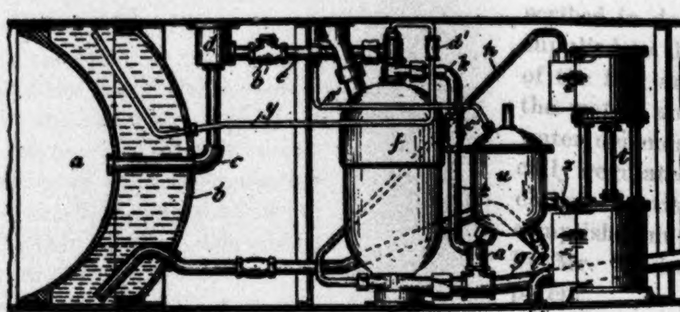


FIG. 3.

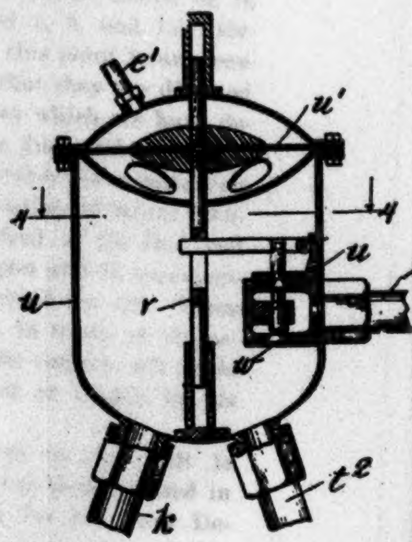


FIG. 2.

more, it will be observed, the arrangement is such, that if, for any reason such as the breaking down of the water pump, the flow of water into the regulator chamber is interrupted, the supply of fuel will immediately cease, thus bringing the combustion to an end and preventing unduly high temperatures; but, nevertheless, the air or oxygen under pressure will continue to flow from the storage tank through the combustion chamber to the engine, and the torpedo will continue to be driven until the supply of oxygen-carrier under pressure is exhausted."

The Question Presented in This Suit.

The claims of the Davison patent relied on in this suit are those numbered 1, 5, and 13. Extended discussion of them at this point is unnecessary; it is sufficient to state that they are directed to the steam generator system which we have described in detail, wherein air, fuel and water are supplied to the generator chamber for combustion of the fuel and air and generation of steam from the water, and wherein the feed of the fuel and water depends at all times upon and is automatically regulated by the pressure of the air. These claims constitute a definition, in brief, of the accomplishment in the automobile torpedo art made by Mr. Davison and described at length in his patent.

The sole question presented in this suit is whether or not this invention has been utilized in the automobile torpedoes made for the Navy Department. No question arises as to the validity

of the Davison patent because appellee is a licensee under the patent.

In *Eclipse Bicycle Co.* vs. *Farrow,* 199 U. S., 581; 50 L. Ed., 317, this Court said:

> "The use of the word 'invention' does not open the state of the art and allow the defendant to meet the plaintiff's claim by proving that he had invented nothing new."

This rule, announced and enforced in many cases, was held to apply in a suit against the United States in *Harvey Steel Company* vs. *United States,* 196 U. S., 310; 49 L. Ed., 492.

Therefore, it remains only to consider appellee's torpedo and ascertain whether or not it embodies the invention made by Mr. Davison and covered by claims 1, 5 and 13 of the Davison patent. Appellee's construction is adequately illustrated and described in Exhibit III (Rec., pp. 31-2) and the Davison patent must be construed, particularly with respect to the claims indicated, to determine whether or not appellee's construction falls within it.

This is a question of law to be decided by the Court, in accordance with *Singer Manufacturing Co.* vs. *Cramer,* 192 U. S., 265, 275; 48 L. Ed., 437, 444. In the Singer case, this Court considered the record of the proceedings in the Patent Office leading up to the grant of the patent in suit and various patents of the prior art and by reference thereto fixed the scope of the patent in suit, and then determined whether or not the defendant's construction was within the patent, saying, by Mr. Justice White:

> "the question of infringement or no infringement is one of law, and susceptible of determ-

carrying motive fluid from the generator chamber D to the steering engines. These parts, however, have no direct bearing on the issues of this suit.

The operation, in all respects except the most specific ones, is precisely the same as that above described in connection with the Davison patent. When the torpedo is discharged, a starting lever is actuated which releases the reducing valve C. Air at the high pressure existing within the reservoir A then flows through the pipe B to the reducing valve C and passes through that valve, the air flowing from the valve being at the reduced and substantially uniform pressure of 350 pounds. This air at the reduced pressure passes from the reducing valve C into the top of the generator D, through the generator and through the pipe T to the nozzles at the end of pipe T which direct the air upon the wheels 53 of the turbine to drive the turbine and the propellers to which it is connected, thereby propelling the torpedo through the water. For a few seconds at the beginning of the run, the torpedo is propelled by compressed air in this manner, the turbine engine operating as a cold air engine. At the same time, air from the low pressure side of the reducing valve C and at the reduced pressure of 350 pounds, passes through the pipe G and the pipes H and J to the water and fuel reservoirs O and P, so that the liquids in these reservoirs are subjected to the pressure of that air, namely, a pressure of 350 pounds. Actuated by this pressure, the water and fuel flow out through the pipes M and N to the top of the generator chamber D. Within that chamber, the fuel mixes with the air to form a combustible mixture and this mixture is ignited by the igniter or pistol U on the top of the generator chamber. The hot

products of the combustion of the air and fuel mingle with the water admitted through the pipe M, thereby generating steam which passes through the pipe T to the turbine. All of these operations preliminary to the generation of steam within the generator D take place almost instantaneously, and thereafter, throughout the run of the torpedo, steam is developed in the generator D and flows to the turbine to operate the latter.

The construction of individual parts shown on Exhibit III, is illustrated by Exhibits B-1, B-2 and B-3. Exhibit B-1 (Rec. opposite p. 37) shows the reducing valve. The high pressure air enters at B, flows past a control valve 14 which is lifted when the mechanism starts, then past a valve-member Z, then into and through a chamber Y, and then through the perforation in a washer J and into the generator chamber. The valve-member Z controls the reduction of the pressure of the air. It is provided with a tapered surface which coacts with a similar-shaped valve-seat shown at V in the detached view in the lower right hand corner of the exhibit. This valve-member Z moves within narrow limits during the operation of the apparatus, under the control of the air pressure and a coiled spring 17 in the lower part of the reducing valve casing 12, and it allows the high pressure air to pass the valve-member at such a rate that the pressure beyond the valve-member in the chamber Y is maintained uniform and at the desired point, namely, 350 pounds.

Exhibits B-2 and B-3 illustrate the construction of the generator chamber. In its upper portion is a perforated baffle-plate 35. The air from the reducing valve enters the space above this baffle-plate and passes through the perforations in it. The fuel is sprayed into the space immediately be-

low the baffle-plate by the fuel inlet nozzle illustrated at 26. The fuel becomes intimately mixed with the air and the mixture thus formed is ignited by the pistol 22. Water is admitted to the generator chamber by the water spray device which is illustrated at 28.

The turbine engine and the pipe T leading from the generator to the engine are so constructed that the pressure within the generator chamber D is maintained practically constant and at a point somewhat below the pressure of the low pressure air passing through the reducing valve. In practice, the pressure within the generator D is about 300 pounds and any rise in pressure above that point results in higher speed of operation of the turbine which brings the pressure down to 300 pounds at once. Thus, there is a drop in pressure of 50 pounds from the low pressure side of the reducing valve, that is, the chamber Y where the pressure is 350 pounds, to the interior of the generator. This drop in pressure is due to the fact that there is a restriction in the air passage from the reducing valve to the generator. This restriction occurs at the perforated washer J, Exhibit B-1, which is inserted between the reducing valve casting and the generator casting; it will be noted that the passage through this washer J is materially smaller than the air passage Y on the low pressure side of the reducing valve. It is this drop of pressure of 50 pounds, which causes the air to flow from the reducing valve into the generator. Also, it is to be noted particularly that this same pressure of 50 pounds is effective upon the fuel and water to feed them into the generator, because the pipe G, Exhibit III, is connected to the low pressure side of the reducing valve at the opening W shown on Exhibit B-1. In other words, air at the pressure of 350 pounds existing within chamber Y

passes through the opening W and the pipe G to the fuel and water receptacles and that pressure is effective upon the fuel and water to force them through the pipes N and M and into the generator D where a pressure of 300 pounds exists. The fuel and water are, therefore, forced into the generator chamber by the same pressure which causes the flow of air into the generator chamber. Any increase or decrease of the pressure of the air on the low pressure side of the reducing valve, resulting in an increase or decrease of the rate of flow of air into the generator chamber, effects an immediate and corresponding increase or decrease in the pressure upon the fuel and water tending to force them into the generator chamber. It results inevitably from this that the air, fuel and water are forced into the generator chamber at all times in definite proportions.

From the foregoing description of appellee's construction, it must be apparent at once that in all essential respects it is identical with the construction of the Davison patent. It is like that construction and different from the prior constructions employing the outside superheater in that water is injected into the hot products of the combustion of air and fuel for the purpose of generating steam which is supplied to the propelling engine to operate it. Instead of a superheater for heating air passing to the engine by burning fuel and a small portion of the oxygen in the air within the superheater, it employs a generator wherein the hot products of the combustion of a much larger amount of fuel and substantially all of the oxygen in the air admitted to the generator are combined with water to evaporate the water and produce steam, which steam conserves the energy in the hot products of the combustion and has a temperature which is

quite low enough to permit of introducing it safely into the engine. Furthermore, *appellee's construction is like that of the Davison patent in that the rate of feed of the fuel and water into the generator chamber is automatically regulated at all times with respect to the rate of feed of the air into the generator chamber.* Any change in the rate at which air is supplied to the generator is accompanied by an immediate and corresponding change in the rate of supply of fuel and water to the generator. The relation or proportion of these three ingredients is maintained automatically, and these proportions may be so selected as to result in the highest efficiency of operation. Thus the rate of supply of fuel may be such that all of the oxygen in the air admitted will be utilized for combustion. The air may be enriched by increasing its content of oxygen and then even more fuel may be burned, resulting in the development of even more power. Also, the proportion of the water may be such that it will be adequate for reducing the temperature of the hot products of combustion down below the danger point, substituting steam for highly heated air and conserving the total energy developed, without providing any excess which would pass into the engine as water.

Finally, appellee's construction is like that of the Davison patent and different from the best of the prior constructions in that *its range far exceeds anything the prior art had ever known.* It represents the attainment of the object which Mr. Davison had in view from the start to the finish of his work. The Navy Department has in it the weapon which it lacked in 1911 and sought to obtain from Mr. Davison. Its range is 7000 or 10,000 yards, according to size, and the best of the prior types had a range of about 4000 yards (Rec., p. 9).

Difference between Appellee's and the Patented Constructions.

The only difference worthy of comment between appellee's and the patented constructions relates to the automatic regulator shown in Fig. 3 of the Davison patent. Brief discussion of it seems desirable to avoid a possible misunderstanding.

It will be noted that appellee's torpedo has reservoirs P and O for fuel and water. These reservoirs must be filled before the torpedo is launched. As the fuel and water are consumed during a run, the spaces occupied by them are filled with air. Thus, as the fuel and water drawn from the reservoirs P and O are consumed, the weight of the torpedo decreases, tending to cause it to rise to the surface, and also, the center of gravity of the torpedo shifts, tending to decrease the stability of the torpedo in the water. Obviously, such changes of operating conditions during the run of the torpedo are objectionable. Mr. Davison, in the course of the development of his invention, conceived the idea that these objectionable characteristics could be greatly reduced or even eliminated by drawing water from the sea; instead of starting with a large supply which would be diminished steadily during the run, a small supply could be carried by the torpedo and be replenished constantly from the sea during the run. This solved the difficulty so far as the water is concerned and as to the fuel, it could be forced into the generator chamber by water instead of air, without any substantial change of weight.

Such a construction seemed to present advantages of substantial value over carrying supplies of fuel and water sufficient for the entire run and feeding the fuel and water into the generator by

the direct application of air pressure, as is done in appellee's construction.

Accordingly, this further improvement made by Mr. Davison was developed and utilized and it is illustrated and described in the patent. The water is drawn in from the sea through the pipe t^1 (p. 36) and is forced by the pump t through pipes x and k to the generator f; it is also forced by the pump through pipes x and t^2 into the fuel chamber b where it displaces the fuel by forcing it out through the pipe y to the generator f. In order to employ such a construction in conjunction with the main Davison invention, it was necessary to provide for controlling the rate at which the water and fuel are fed into the generator chamber in direct accordance with the air pressure forcing the air into that chamber. This led to the automatic regulator u shown in Fig. 3 of the patent. It operates, as has been explained, to regulate the freedom of flow of water from the pump into the regulator so that the water pressure within the regulator will always bear a definite relation to the air pressure on the low pressure side of the reducing valve, because that air pressure is applied to the upper side of the diaphragm u^1 through the pipe e^1. The effect is identically the same as if the air pressure were applied through the pipe e^1 directly to the water and fuel in the reservoirs as in appellee's construction, but the interposition of the regulator controlled by the air pressure permits of supplying water from the sea as it is consumed in the generator instead of carrying enough for the entire run in the reservoir.

This construction has other advantageous features which commended it to Mr. Davison. In appellee's construction, as fuel is consumed, the

space in the fuel tank is filled with air, and hydrocarbon vapor rising from the surface of the fuel within the tank and mingling with the air therein produces an explosive mixture. With the Davison construction wherein the fuel is forced out by water, that cannot occur and the element of danger is correspondingly reduced.

Furthermore, with the Davison construction the flow of fuel cannot continue if the flow of water becomes stopped. With appellee's construction, there is the possibility that the flow of water might be stopped by some obstruction and in that case the flow of fuel would continue with the result that highly heated air would pass into the generator at a temperature which would melt the metal.

These desirable characteristics attained by the use of the regulator were fully realized by Mr. Davison and were pointed out by him in his patent. But he realized also that these features were subsidiary to and refinements upon the general principle of making the feed of the fuel and water dependent upon the feed of the air so that the flow of all three of these ingredients would vary together, and that this principle could be utilized as appellee has utilized it by causing the air to act directly upon the fuel and water just as well as by causing the air to act indirectly upon them through the intermediacy of a pump and a regulator as is illustrated in the Davison patent. This is made clear by the language of the patent, notably that appearing at the middle of page 27 of the record and that employed in claim 13 on page 31.

This difference between appellee's and the Davison constructions is, therefore, a difference which has no bearing whatever upon the issues of this

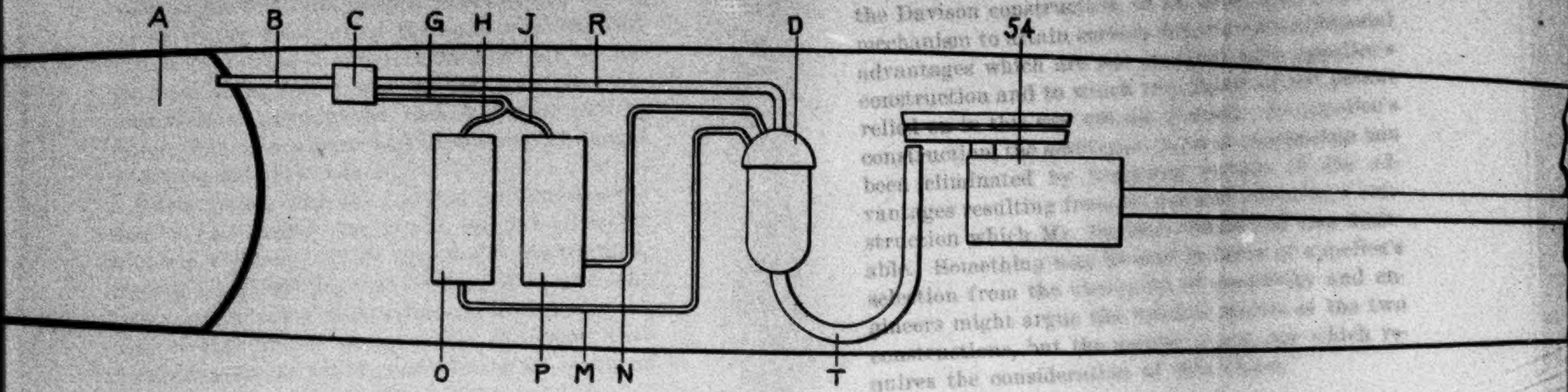
suit. It involves nothing more than the use, in the Davison construction, of an additional piece of mechanism to attain certain desirable and additional advantages which are not obtained with appellee's construction and to which the claims of the patent relied on in this suit are not limited. In appellee's construction, the additional piece of mechanism has been eliminated by foregoing certain of the advantages resulting from its use and adopting a construction which Mr. Davison considered less desirable. Something may be said in favor of appellee's selection from the standpoint of simplicity and engineers might argue the relative merits of the two constructions, but the matter is not one which requires the consideration of this court.

The Claims of the Davison Patent.

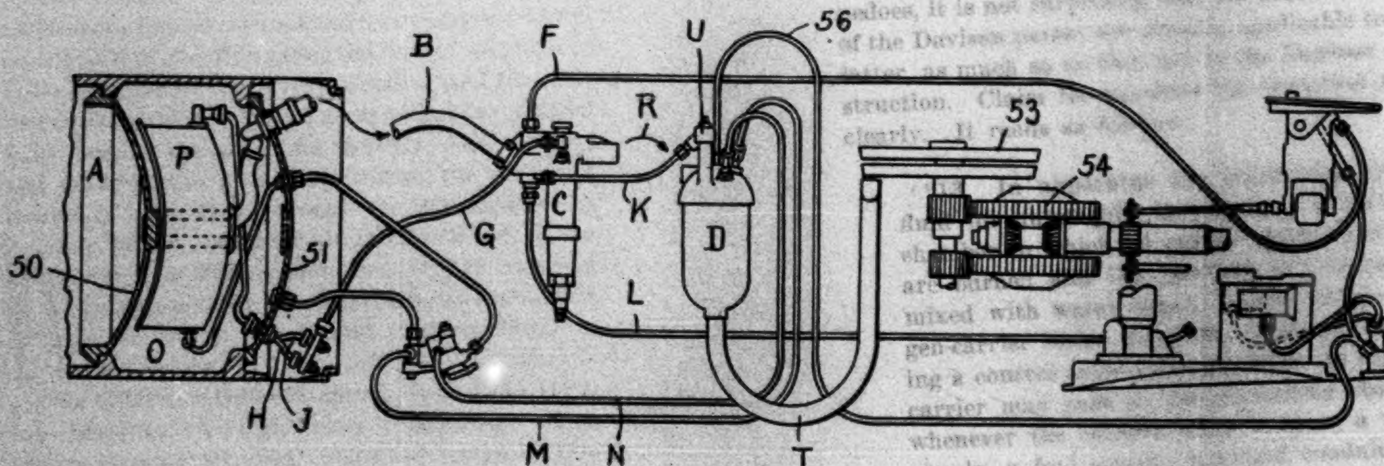
In view of the identity of structure and operation between the Davison and the appellee's torpedoes, it is not surprising that the broader claims of the Davison patent are directly applicable to the latter, as much as to the use of Mr. Davison's construction. Claim 13 illustrates this situation most clearly. It reads as follows:

> "13. In apparatus for producing motive fluid for automobile torpedoes, a combustion chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water, means for storing oxygen-carrier under pressure, a conduit including a control valve through which the oxygen-carrier may pass to the combustion chamber whenever the control valve is open, a water supply, a fuel supply, a pressure reducing valve

SIMPLIFIED DIAGRAM OF APPELLEE'S CONSTRUCTION.



APPELLEE'S CONSTRUCTION



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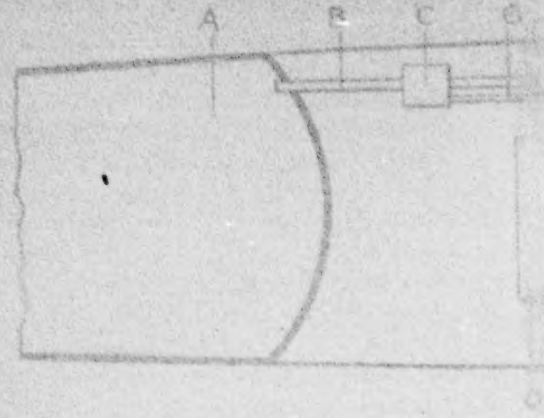

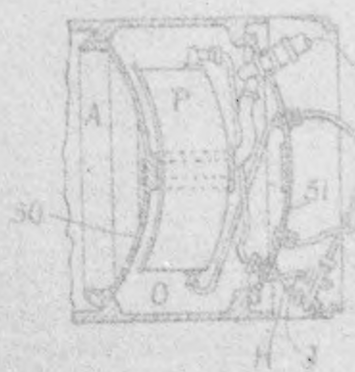

suit. It involves nothing more than the use, in the Davison construction, of an additional piece of mechanism to attain certain definite and additional advantages which are not attained with appellee's construction and to which the claims of the patent relied on in this suit are not limited. In appellee's construction, the additional piece of mechanism has been eliminated by foregoing certain of the advantages resulting from its use and adopting a construction which Mr. Davison considered less desirable. Something may be said in favor of appellee's selection from the viewpoint of simplicity and engineers might argue the relative merits of the two constructions, but the matter is not one which requires the consideration of this Court.

The Claims of the Davison Patent.

In view of the identity of structure and operation between the Davison and the appellee's torpedoes, it is not surprising that the broader claims of the Davison patent are directly applicable to the latter, as much so as they are to the Davison construction. Claim 13 expresses the invention most clearly. It reads as follows:

> "13. In apparatus for generating motive fluid for automobile torpedoes, a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor, a tank for an oxygen-carrier under pressure, a conduit including a control valve through which the oxygen-carrier may pass to the generating chamber whenever the control valve is open, a water supply, a fuel supply, a second conduit like-

> wise controlled by said valve and through which the pressure of the oxygen-carrier is applied to the fuel and water supply, and conduits through which the fuel and water may freely pass, under such pressure, into the generating chamber, whereby the water and fuel feed depends at all times upon the pressure of the oxygen-carrier."

Comment on this claim and the complete fulfilment of all its requirements by appellee's torpedo, seems unnecessary, in view of the foregoing description of the construction. There can be no question, and in fact it has not been denied, that appellee's construction as above described, includes an apparatus for generating motive fluid for automobile torpedoes having a generating chamber in which an oxygen-carrier and fuel are burned and the products of combustion mixed with water vapor. In connection with this wording of the claim, it may be noted that the term "oxygen-carrier" is used throughout the Davison patent, as Mr. Davison's invention contemplated either the use of atmospheric air which contains about 23 per cent. of oxygen or air enriched to contain any desired proportion of oxygen, and therefore some term other than "air," was required. Likewise, there is no ground for question, and it has not been denied, that appellee's construction includes a tank A for the oxygen-carrier under pressure, a conduit B including a control valve C through which the oxygen-carrier may pass to the generating chamber D whenever the valve C is open, a water supply O, a fuel supply P, a second conduit G likewise controlled by the valve C and

through which the pressure of the oxygen-carrier is applied to the fuel and water supply by direct contact of the air therewith, and conduits N and M through which the fuel and water may freely pass under the air pressure into the generating chamber D, whereby the water and the fuel feed depends at all times upon the pressure of the oxygen-carrier. Every word of this claim is directly applicable to the construction of appellee's torpedo; in fact, it could not be more applicable. The same wording could properly have been selected if it had been appellee's construction which was illustrated and described in the Davison patent.

Claims 1 and 5 are directed to the same subject-matter and are relied upon as infringed, but claim 13 expresses and defines the inventive idea most clearly and therefore detailed discussion of claims 1 and 5 is unnecessary. The other claims of the patent refer specifically to the refinements we have described above including the pump drawing water from the sea, the feeding of the fuel into the generator chamber by the water and the specific construction of the regulator with its rubber diaphragm and the generator chamber with its dome-shaped hood.

From the foregoing, there seems to be no opportunity for a divergence of view as to the fact that so far as concerns the elements specified in claim 13, there is no difference between Davison's and appellee's constructions. The requirements of the claim are wholly independent of any minor feature of specific structure wherein a difference between the two constructions may be found and the claim contains no words which may be construed as lim-

iting their meaning or scope to such specific structural features. If the claim be given the meaning which one would naturally give it, understanding each word employed in the claim to have its usual and commonly-accepted meaning, the conclusion is inevitable that appellee's construction comes within it.

If the meaning of the claim were obscure and difficult to understand even with the aid of the specification of the patent, there would then be a reason, in fact a necessity, for looking to other sources for assistance in arriving at the proper interpretation of the claim; and under the pressure of this necessity, the whole of the prior art might well be examined in order to ascertain the true scope of the invention which is claimed and the true meaning of the claim purporting to cover that invention. But in such a case as this, where there is nothing in the claim which is obscure and must be made clear, nothing which is vague and must be made definite, there can be no reason why the claim should not be interpreted by giving to the words employed their natural and usual meaning. And if the claim be so interpreted, there can be no argument for non-infringement, except an argument based upon a violent reading into the claim of some element which it does not on its face contain. This would not be permissible in the case of an ordinary infringement suit, and is much less so in a suit on a contract against a licensee.

There is No Occasion for Considering the Prior Art Under the Circumstances of this Case.

In view of the license, this case should be decided solely on the result of a comparison of the Davison

invention as it is described in the patent and defined, for example, in claim 13, and Appellee's torpedo as it is illustrated and described by Exhibits III and B-1 to B-4. As there is nothing ambiguous or obscure in the specification or claim, there is no occasion for examination of the prior patents forming Exhibits C-1 to C-15, and this suit should be decided without reference to them, for examination of prior art patents is not appropriate either for the purpose of establishing the invalidity of the claim relied upon or for the purpose of imposing on the claim a construction which narrows its scope beyond its plain meaning.

It is certainly clear that a licensee is estopped from denying the validity of the patent covered by his license and this is just as true when the licensee is the United States as when the licensee is an individual (*Harvey Steel Co.* vs. *U. S.*, 196 U. S., 312; 40 L. Ed., 492).

But the principle goes further than this. The licensee is estopped from reading into a plain and unambiguous claim some element not actually present there, and from relying upon the prior art in support of a contention that such a construction of the claim is necessary. If a claim could be given some strained meaning and limited scope, out of all harmony with the usual and accepted meaning of the words employed and with the description of the invention contained in the specification, then the whole effect of the rule that the claim must be assumed to be valid because of the license, would be frustrated. Therefore, "the fair meaning of the language of the claim" must determine the scope of the invention in a suit against the licensee.

There appears to be no decision of this court directly on this point, though in the *Eclipse Bicycle case* (*ante*, page 38) the bearing of the prior art on a patent covered by a license contract was urged by the defendant and does not appear to have been considered by the Court, which said that defendant's argument "gave too little effect to the contract."

The lower Courts have had frequent occasion to consider such situations. The Circuit Court of Appeals for the Seventh Circuit has announced a definite rule which is stated as follows in the leading case on the point in that Circuit:

> "In our judgment the reason of the case leads to the conclusion that, between contracting parties, extraneous evidence is inadmissible if there is no ambiguity or uncertainty in the language of the description and claims, and that, if there is uncertainty, outside evidence is admissible only to make clear what the applicant meant to claim and the government to allow, and not for the purpose of showing, even in the slightest degree, that the applicant had no right to claim and that the Government was improvident in allowing what was in fact claimed and allowed. And the conclusion accords, we think, with the weight of authority." (Cases cited.)
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> *Siemens-Halske Electric Co.* vs. *Duncan Electric Mfg. Co.*, 142 Fed. Rep., 157,

This rule has been discussed and applied in numerous other cases in the Seventh Circuit, including the following:

Chicago & A. Ry. Co. vs. *Pressed Steel Car Co.*, 243 Fed. Rep., 883;
National Recording Safe Co. vs. *International Safe Co.*, 158 Fed. Rep., 824.

Cases in other Circuit Courts of Appeals in which the same principle has been applied without announcing a definite rule are:

United Printing Machinery Co. vs. *Cross Paper Feeder Co.*, 227 Fed. Rep., 600 (C. C. A., 1st Circuit);
Leader Plow Co. vs. *Bridgewater Plow Co.*, 237 Fed. Rep., 376 (C. C. A., 4th Circuit);
U. S. Frumentum Co. vs. *Lauhoff*, 216 Fed. Rep., 610 (C. C. A., 6th Circuit).

In some cases in Circuits other than the Seventh, this rule has not been applied so rigidly and in some instances an effort has been made to differentiate between admitting in evidence the patents of the prior art for the purpose of showing anticipation of the patent in suit and admitting them for the purpose of showing limitation of the scope of the patent. In our belief, the instances in which this has been done show clearly that the asserted distinction is one of words and not of substance; except in the exceedingly rare instance of identity of the patented invention and a proven anticipation, it is always possible to hold that the patent in suit is valid but limited to the precise structure shown in its drawing and the practical effect is the same as if the patent were held to be invalid. So admission of the prior art on the ground that its examination is justified in order to fix the scope of

the patent in suit (unless the claims of the patent are, on their face, ambiguous) is, in its practical effect, equivalent to releasing the defendant from the estoppel arising by reason of being a licensee under the patent or having assigned the patent to the plaintiff.

Refusal to examine and consider such extraneous evidence as the prior patents accompanying the Findings would be particularly appropriate in this case in view of the special facts incident to the execution of the license. At the time of its execution, appellee had just received the first torpedo of the type on which royalty is now claimed and knew from records of tests that it had attained a range of 10,000 yards as against 4,000 yards for the best ones previously available. That was what led appellee to seek the license. Its representatives knew that the Navy Department would want to purchase and use the new 10,000 yard torpedoes and that they utilized the Steam Generator developed by Davison. Thus the parties had in contemplation, at the time the license was signed, the identical type of torpedo on which appellee is now asked to pay the stipulated royalty. This involves a succession of events which will now be discussed.

History of the Contract in Suit.

The events which led up to the license agreement are set forth at length in Findings V to X and they constitute such a large proportion of the total Findings that one would expect to find in those events the basis for the Court's conclusion, facts from which the conclusion follows necessarily. The actual fact, however, is very different. Not only do the events covered by the Findings fail to support

the conclusion set forth in Finding XV, but, on the contrary, they furnish strong indication that the conclusion is erroneous.

In the fall of 1910, some two years after Davison started his work on the steam generator and after the filing of his application for the patent in suit, and after he had been urged by the Navy Department to persist in the work of developing the long-range torpedo by the use of his steam generator (Finding VI, Rec., pp. 11-12), the Navy Department entered into contracts with appellant and with E. W. Bliss Company which had long been established in the business of making for the Navy torpedoes of the inside and outside superheater types. These contracts provided for manufacture by the two companies of experimental torpedoes designed to attain greatly increased range, and to be paid for on a sliding scale of prices increasing with range and speed (Finding VIII, p. 13). Appellants' torpedo, as we have stated above, attained a range of 6,000 yards, 50% greater than the previous superheater torpedoes. The Bliss Company with its extensive facilities for making torpedoes, was able, by the use of Davison's invention, to do even better. Its torpedo attained a range of 10,000 yards at a speed of 26 knots.

It was immediately after the Bliss torpedo had run this long range that the Navy Department solicited and obtained from appellant a license under the Davison patents. It was that situation which induced the Navy officials to solicit the license. They felt the license must be had. They knew of Davison's work on the development of the steam generator and knew that the Bliss torpedo which attained the 10,000 yard range utilized the steam generator just as Davison planned to use it, and since they knew that the torpedoes then in

service were deficient because of their short range, they must have realized at once that the Navy would want to purchase the new long range torpedoes in the future. So they needed a license under Davison's patent and that was what they got under the agreement now before the Court. There was no misapprehension whatever; they all knew what the license meant and what its purpose and effect were. They knew those things the better because one of the officials consulted advised against entering into the license on the ground that it would obligate the Government to pay royalty on torpedoes like the Bliss torpedo (Finding IX, Rec., pp. 15-16). That doubtless led to more extended and more careful consideration. Then when this extended consideration led to the decision to become a licensee under the patents, there was an exchange of letters which shows the intended scope of the license (Finding X, pp. 17-18). The Navy Department called it a "shop license" and asked the appellant to insert the name of the device and the numbers of the patents under which the "shop license" was granted. In reply, appellant pointed out that the license must be understood to cover "torpedoes which the Government may build at its own works," as well as any that might be built by others. The parties being in accord as to all such matters, the agreement was drawn up by the Navy Department and sent to appellant for signature (Rec., p. 18).

These matters are so important in showing how the contract came to be made and the purpose of the parties in making it and what the parties to it understood it to mean, that they should be set forth in greater detail.

It was on September 6, 1910, shortly after the Newport Torpedo Station had discontinued its work on the steam generator and the torpedo officer

of the Navy Department had urged Davison to persist in his development work thereon, that the Navy Department entered into contracts with appellant and the Bliss Company for the manufacture of experimental long range torpedoes (Rec., p. 13). And it was toward the end of 1911 that the Bliss Company completed and tested the torpedo which it made under its contract and which attained a range of 10,000 yards (Rec., p. 14).

About the same time, on October 20, 1911, appellant wrote to the Navy Department offering to convert existing superheater torpedoes to steam generator torpedoes and offering a license under the Davison patents on a royalty basis (Rec., p. 14). This letter was transmitted to the officer in command of the Newport Torpedo Station for his comment. That officer appreciated that the proposal involved the injection of water and called attention to the fact that the Bliss Company was "proceeding along the same lines," and under date of October 27, 1911, he recorded his opposition to entering into a license agreement with appellant as follows:

> "In view of the above it is not considered wise to enter into an agreement with the Electric Boat Company by which the bureau agrees to pay the Electric Boat Company a royalty for the use of a device in torpedoes *presumably similar to devices made by other companies*, and to one which is in the course of development at the torpedo station, as by that action the bureau would, in the opinion of the torpedo station, possibly involve itself in dispute if not in litigation with the other companies, and would be estopped from further development of its own superheaters" (Rec., p. 15). (Italics ours.)

The torpedo officer of the Navy Department replied to this on November 2, 1911, by calling attention to the fact that the steam generator of the Electric Boat Company "has been patended," saying:

> "The attached correspondence is in reference to an entirely different proposition and yet connected with that proposition, inasmuch as the steam generating device will be incorporated in the Davison torpedoes, and the bureau is given to understand that this generator is not in any sense a superheater, that it *has been patented,* and it is not to conflict with the present superheater rights" (Rec., p. 16). (Italics ours.)

Again, on November 4, 1911, the officer of the Torpedo Station expressed his opposition as follows:

> "The torpedo station is still of the opinion that it would be unwise to enter into any royalty agreement with the Electric Boat Company in regard to the steam generator device of a torpedo until the details of this device are thoroughly well known and it is clearly established that the device is different from other patented devices of the same nature, and the torpedo station's previous comments were merely to recommend the nonacceptance of the Electric Boat Company's proposition as submitted, without detailed description."

Within less than a week thereafter, on November 9, 1911, the Navy Department wrote to appellant that:

"Referring to the matter of royalties, the bureau will have drawn up an agreement by which it will agree to pay a royalty" (Rec., p. 17).

A few weeks later, on December 6, 1911, appellant wrote the Navy Department a letter whose obvious purpose was to eliminate any possible doubt as to what the proposed license agreement would cover. Appellant's letter stated:

"It is our understanding that the royalty will apply not only to torpedoes which may hereafter be converted but also to torpedoes which the Government may build at its own works and in which the device in question is to be used" (Rec., p. 18).

The Navy Department acknowledged receipt of this letter on December 13, 1911, and stated that it was "forwarding a blank shop license or agreement." In drafting this agreement, the Department not only adopted appellant's requirement that the license cover "torpedoes which the Government may build at its own works" but went further and provided that the license should cover torpedoes made by the Department "either in its own shops or by contract in private shops."

In view of these simple facts and the plain language of the license agreement, the meaning of the agreement, what the parties intended to cover by it and what they actually did cover, are clear beyond the possibility of dispute. The thing which appellee was licensed to manufacture is explicitly defined, without ambiguity, at three places in the contract, as follows (Rec., pp. 19-20).

Paragraph 1. "torpedoes equipped with Steam Generator for Automobile Torpedoes

covered by application Serial No. 422,175, dated March 9, 1908; application Serial No. 486,455, dated March 29, 1909; application Serial No. 590,627, dated Nov. 10, 1910; U. S. Patent Serial No. 980,243, dated Jan. 3, 1911, and any improvements thereon now or hereafter owned or controlled by the party of the first part * * * to the end of the term for which Letters Patent for said invention and any improvement thereon have been or may be granted."

Paragraph 2. "torpedoes equipped with the Steam Generator for Automobile Torpedoes covered by the application for Letters Patent and Letters Patent before mentioned."

Paragraph 3. "the device covered by the application for Letters Patent and Letters Patent hereinbefore mentioned, to wit, the Steam Generator for Automobile Torpedoes, or any improvements thereon now or hereafter owned or controlled by said party of the first part."

After considering the license agreement, the Court of Claims found the only thing, as it seems to us, any Court could find, namely,

> "The Government agreed to pay a substantial sum for each of the torpedoes made and accepted in accordance with the license, and containing the inventions set forth in the letters patent and the applications for letters patent enumerated in the agreement" (*post*, p. 99).

This interpretation of the contract adopted by the Court is necessary and inevitable from the lan-

guage of the contract itself; and the correspondence leading up to the contract shows that a contract of just that meaning is just what the parties to the contract intended. Furthermore, that the parties understood that the Bliss torpedo was within the license covered by the contract is plainly indicated, for it was the only torpedo then in existence which had run a long range, the contract was solicited by the Department immediately after it had run the long range, the Department's attention was called to the fact that the Davison torpedo was "presumably similar to devices made by other companies," and that the Bliss torpedo was a water injection torpedo made by "proceeding along the same lines" as Davison (Rec., p. 15), and, as soon as the license was in a form approved by both parties, the Department proceeded to order 50 torpedoes like the one which ran 10,000 yards on the test (Rec., p. 14).

Harvey Steel Co. vs. U. S.

The situation presented in this suit is strikingly similar to that which was before the Court in Harvey Steel Co. vs. U. S., 196 U. S., 310; 49 L. Ed., 492. That case was based on a license agreement relating to a patented process for hardening steel to make armor plate, known throughout the negotiations leading up to the license and designated in the license as the "Harvey process." In the suit the defendant contended that the process actually used by it was different from that described in the patent to such extent as to be outside the scope of the patent. The Court of Claims found that the process actually used by the defendant was called the Harvey process and was gen-

erally understood to be the Harvey process which had become available to the defendant by reason of Harvey's efforts; for that reason the Court refused to enter upon an examination of the Harvey patent and the prior art in the effort to fix the scope of the patent and determine whether or not the process actually used by the defendant fell within it.

On appeal, this Court affirmed the action of the Court of Claims, saying:

> "It is argued that the agreement was only to pay for the use of the process covered by the patent named, and that if the meaning of the parties was to cover anything broader than the patent, even what was known in their speech as the Harvey process, that meaning could be imported into the contract only by reformation, not by construction of the contract as it stands. But we are of opinion that this defense also must fail. * * * But the fact that the parties assumed that the process used and intended to be used was covered by the patent works both ways. It shows that they thought and meant that the agreement covered and should cover, the process actually used. We think that this can be gathered from the agreement itself, apart from the mere supposition of the parties. The contract dealt with a process 'known as the Harvey process.' It imported the speech of the parties and the common speech of the time into the description of the subject-matter."

The present case presents a close parallel. A representative of the Navy Department was informed of Davison's invention and urged him to

The Leavitt Patent No. 693,872.

This patent discloses an excellent example of the second stage of the evolution of the present-day long range torpedo as set forth in Finding IV (Rec., p. 9), that is, the stage characterized by the use of torpedoes of the inside superheater type. In fact, it is our understanding that the inside superheater torpedoes used by the United States Navy were made under this Leavitt patent. This type has been described sufficiently heretofore (*ante*, pp. 16-17).

Sodeau British Patent 15,997 and U. S. Patent No. 835,262.

These United States and British patents represent the third stage in the evolution of the long range torpedo, namely, that characterized by the use of the outside superheater. It is our understanding that the torpedoes of that type used by the United States Navy were made under the protection of these patents. Further comment on them would seem to be unnecessary for it was this outside superheater torpedo which was found to be deficient in practice because its range was much too short and it was because of this that Davison undertook to provide a power plant which would drive a torpedo a longer distance. These outside superheater torpedoes have also been described (*ante*, pp. 17-19).

De Ferranti British Patent 9496 of 1904.

This British patent consists of the patentee's speculations on a great succession of proposals of power plants to be employed in torpedoes, sub-

marine boats and elsewhere and makes extravagant claims as to the results which would be obtained by them, or rather, the results which the patentee hoped would be obtained. Specific directions as to the application of the ideas are conspicuously absent. Along with a great mass of other general suggestions as to how turbines may be operated by compressed air, the patent proposes that air, fuel and water be admitted to the combustion chamber of an automobile torpedo for combustion of the air and fuel and introduction of the water into the products of combustion to generate steam, *but with no suggestion of any automatic regulation of the relative proportions of these three ingredients.* De Ferranti's suggestion is quite distinct from Davison's invention and from the combinations covered by the claims relied upon in this suit in that De Ferranti illustrates and describes the fuel and water as fed into the combustion chamber by mechanically driven pumps geared to the propeller shafts. Thus, the rate of feed of water and fuel into the combustion chamber is made to depend upon the speed of the engine instead of upon the pressure of the air and therefore on the rate of feed of the air into the combustion chamber. Because of this, De Ferranti's proposal differs from Davison's invention in a respect which is emphasized as of importance in the Davison patent, a respect which is made a definite requirement of Davison's claims, and a respect in which the Davison invention and appellee's torpedo are precisely the same.

The De Ferranti patent corresponds to another Davison patent covered by the license, namely No. 1,036,082, to which we have heretofore referred (*ante,* p. 14).

Sodeau British Patent No. 6081 of 1907.

Figures 1 to 5 of this patent show constructions which bear a marked resemblance to Figure 2 of the Sodeau U. S. patent No. 835,262. The superheater is shown at *g* and air flows into it at one end through pipe *f* and out at the other end through a similar pipe. The liquid fuel is contained in a reservoir *a* which is connected to the superheater *g* and the pipe *f* by pipes *e* and *b*.

In the introductory portion of the patent, the invention is stated to relate "to heating apparatus such as used in compressed air plant for heating the air before passing the same to a motor" (Rec., p. 50). Thus the subject matter of the invention is definitely characterized as relating to a compressed air power plant in which provision is made for heating the air; in other words, the apparatus is essentially an *air heater* of the type of the superheater shown in the earlier Sodeau patents. The next lines of the patent make this even more clear by stating "In such plant it is known to increase the energy of the compressed air by burning therein a liquid fuel" (Rec., p. 50). The patent then states that the invention relates to the means employed for feeding the fuel into the superheater, that the feed is effected "in accordance with the density of the air flowing through the combustion chamber or the like and proportional to the quantity or rate of flow of such air" and that the feeding means is "dependent upon the kinetic energy of the air" flowing into the superheater (Rec., p. 51). The special provision for effecting the feed into the superheater is, therefore, the invention of this patent,

and hence, that special provision must be considered in detail.

It will be noted that in Fig. 1 of the patent drawings, there is a nozzle *c* located in the air pipe *f* and connected by pipe *b* to the bottom of the fuel chamber *a*. The air rushing through pipe *f* past the nozzle *c* which is pointed in the direction of the air flow, creates a suction at the end of the nozzle. This suction draws the liquid fuel up pipe *b* and out of nozzle *c*. The suction effect is augmented slightly by a funnel *d* which is mounted at the end of the nozzle *c*. The action is much the same as that which takes place in an atomizer for perfumes and medicaments and in the carburetor of an automobile. It is the velocity of the flow of the air which causes it. This velocity effect is what is meant by the kinetic energy of the air as distinguished from the dynamic energy represented by the pressure to which the air has been compressed.

In Fig. 2 of this Sodeau patent, the end of the pipe *h* projecting into the pipe *f* is pointed in the opposite direction, against the flow of air, and this end of the pipe *h* is open. Therefore, the air rushing through pipe *f* in the direction of the arrow impinges upon the open end of the pipe *h*. This impingement, or bombardment as it might be called, of the air particles moving at high velocity through the pipe *f* against the air particles in the open end of the pipe *h* effects a slight increase of pressure in pipe *h* and in the upper end of the fuel tank *a* to which pipe *h* is connected. The increase of pressure here referred to is an increase due wholly to the impingement, that is, due to the kinetic energy of the air, and is quite distinct from

the dynamic energy or static pressure of the air. The air flowing through pipe *f* may be at a high pressure, but that static pressure so far as concerns its effect on the fuel in the tank *a*, is offset by the pressure in the chamber *g* which is exerted back through the pipe *b* in opposition to the flow of the fuel. The kinetic energy of the air in pipe *f*, however, is exerted upon the upper surface of the liquid in tank *a* in addition to the static pressure on that surface and tends to force the liquid through pipe *b* into the chamber *a* where the fuel mixes with air and is burned.

Such a tube as that illustrated at *h* in Fig. 2 of the Sodeau patent is known as a Pitot tube, that is, a tube projecting into the path of travel of a moving fluid and having its end open so that the particles of the moving fluid may impinge upon the particles within the tube. Such Pitot tubes are sometimes used as measuring instruments for measuring the flow of fluids in pipes. Except for some small use in making delicate measurements, the Pitot tube is of little or no utility for the pressure developed by the Pitot effect is feeble in the extreme. Kent's "Mechanical Engineers Pocket Book," long recognized as an authority and widely used by engineers, describes the Pitot tube as follows:

> "The Pitot tube is used for measuring the velocity of fluids in motion. It has been used with great success in measuring the flow of natural gas. It is simply a tube so bent that a short leg extends into the current of fluid flowing from a tube, with the plane of the entering orifice opposed at right angles to the direction of the current. The pressure caused

by the impact of the current is transmitted through the tube to a pressure gauge of any kind, such as a column of water or of mercury or a Bourdon spring gauge. From the pressure thus indicated and the known density and temperature of the flowing gas is obtained the head corresponding to the pressure and from this the velocity."

Obviously, such a Pitot tube would be useful for feeding fuel into a combustion chamber only when the feed of a very small amount of fuel is all that would be desired, an amount comparable to the amount of liquid delivered by an atomizer. It is apparent, therefore, that the feeding means of this Sodeau British patent, consisting of a Pitot tube as in Fig. 2 or an aspirator tube as in Fig. 1, and depending upon the kinetic energy of the air, is adapted for use only when a minute amount of fuel is to be fed and only when the air flows into the generator chamber at a very high rate of speed and only when conditions preclude the use of a feeding means which would require any substantial drop of pressure between the inlet pipe *f* and the chamber *g*. This characteristic of the apparatus illustrated in the patent bears out the statement in its opening paragraph that the invention relates to a heating apparatus for heating compressed air which is supplied to a motor; the apparatus described in the patent belongs very distinctly in the class with the apparatus of the earlier Sodeau patents wherein the object sought is to heat compressed air in the course of its flow from a compressed air reservoir to the point of use.

In connection with Fig. 2, the patent specification recognizes (Rec., p. 51) that the feeding effect of the Pitot tube may be so feeble as to be insufficient in some cases; it states that when the Pitot tube is not "sufficient to effect satisfactorily the feeding", it may be assisted by placing a restriction in the air pipe, as shown at *j*, to create a drop in the static pressure of the air as it flows to the heating chamber and thus increase the rate of feed of the fuel. But the distinctive and characteristic feature of the invention disclosed in this patent is the feeding of the fuel by the kinetic energy of the air flowing at high speed in the pipe leading to the heating chamber, and any feeding of the fuel caused by a reduction of the static pressure of the air due to a restriction in the air pipe must be auxiliary to and in aid of this feed effected by the kinetic energy developed in a Pitot tube or an atomizer in accordance with the feature of the invention which distinguishes it from all others.

Figs. 3, 4 and 5 of the patent show obvious modifications and duplications of the arrangements shown in Figs. 1 and 2. In Figs. 3 and 5, both the Pitot tube of Fig. 2 and the atomizer of Fig. 1 are used together. In Fig. 4, the Pitot tube is used alone and a portion of the air entering it is carried to the fuel nozzle *c* to produce an atomizer effect there.

In Figs. 6 and 7, the idea of the preceding figures is further developed. In addition to feeding fuel into the combustion chamber, water is also fed into that chamber. The fuel reservoir is shown at *a* and a pipe leads into its upper end from a Pitot tube projecting into the pipe through which the compressed air flows into the combustion chamber. From the bottom of the fuel reservoir, a

pipe *b* carries the fuel to a spraying nozzle in the combustion chamber. In addition to these parts, there is a water chamber *n* the upper portion of which is connected to a Pitot tube *p* in the air pipe and the bottom of the reservoir is connected by a pipe *q* to a nozzle *r* in the combustion chamber. With reference to these parts, the patent states (Rec., p. 52):

> "In Figure 6 the form of fuel feed illustrated in Figure 3 is employed and in addition to the fuel tank there is provided a reservoir, *n*, for water, a solution of ammonia salts or the like. The tank, *n*, is connected by a pipe, *o* to a Pitot tube *p*, and by a pipe, *q*, to a nozzle, *r*, in the combustion chamber, whereby water or the like is sprayed into the products of combustion which not only has the effect of cooling these down to a workable point but also adds to the volume of working fluid passed to the engine. In torpedoes where space is somewhat limited this is a point of considerable importance.
>
> "In Figure 7 instead of leading the water or the like from the tank, *n*, directly into the combustion products it is first led through a spiral, *s*, placed conveniently in an enlarged portion, *t*, of the pipe leading from the combustion chamber to the engine. The water or the like is heated while passing through the spiral and is discharged into the combustion products as indicated at, *t*, in the form of a vapor or hot liquid."

In other words, when the combustion of the fuel fed into the combustion chamber and the air in

that chamber causes the temperature of the heated air to rise higher than the apparatus in which the heated air is used will stand without injury, then the water spray may be employed to reduce the temperature "to a workable point." In referring thus to the use of water, it is clear that Sodeau suggested it only as a possible addition to his main invention which was to superheat the air. His invention and his apparatus as he described them in the patent had no possibilities beyond use as an air warmer for supplying heated air as a motive fluid by burning a relatively small amount of fuel and diluting the hot products with the main body of the air.

All this is very different from the invention of Mr. Davison. In all the forms illustrated and described in the Sodeau patent, the apparatus is essentially an air heater, just like the prior types of inside and outside superheaters. It very distinctly is not a steam generator for utilizing compressed air, fuel and water to generate steam as a motive fluid for the propelling engine of a torpedo. There is no suggestion that anything done in accordance with the instruction of the patent will result in the development of an increased amount of energy, thereby making longer ranges for torpedoes possible. There is no suggestion that all the oxygen in the air admitted to the combustion chamber be utilized for combustion, thereby making it possible to burn more fuel and to develop more energy, and the contrary is clearly indicated by the fact that a Pitot tube or an atomizer would feed such a trifling amount of fuel. There is no suggestion that the development of unusually high temperatures in the combustion chamber by burning a large amount of

fuel, instead of being detrimental as it had always been considered, was a real advantage because it made it possible to admit more water which would be transformed into steam. Indeed, the teaching of this Sodeau British patent would seem to lead away from, instead of toward, the improvement in automobile torpedoes represented by the Davison patent. If there is any one thing that definitely characterizes the instruction of the Sodeau patent, it is that a Pitot tube or atomizer, depending for its operation on the kinetic energy of the air, is to be utilized for feeding the fuel, or the fuel and water, into the combustion chamber, and anyone familiar with Pitot tubes and atomizers would know at once that they are capable of developing only extremely low pressures; such a person would know at once that only a very l[illegible]ate of feed of the fuel and water could be attained by using the kinetic energy of the air in any such contrivance as a Pitot tube, and for that reason he would recognize in the Sodeau patent only a novel form of air warmer such as the torpedo art had known and used for years prior to the grant of this patent.

Thus this Sodeau patent fails completely to disclose the inventive idea of the Davison patent. It does not relate to increasing the range of automobile torpedoes by increasing the power developed in a power plant suitable for such a torpedo, and it does not effect the feed of fuel and water into a generator chamber under the automatic control of the pressure of the air flowing into that chamber. Also, it does not comply with the requirements of claim 13 which specifies that the feed of the water and fuel "depends at all times upon the pressure of the oxygen carrier" for in the Sodeau arrangement, such small amounts of water and fuel as would be

fed into the heating chamber would have their feed dependent upon the kinetic energy or velocity of the air instead of its pressure.

One further point requires mention in this connection. When this suit was presented in the Court of Claims the first time, defendant contended that its torpedo did not operate in accordance with the Davison patent, but did operate in accordance with this Sodeau patent. This defense was held insufficient and in the subsequent proceedings, defendant abandoned its original contention entirely and relied on a claim of limitation of the scope of the license agreement (*ante* p. 6).

In answering defendant's original contention that the operation of its torpedo utilized the Pitot pressure of this Sodeau patent, it was impossible for plaintiff to demonstrate that absolutely no Pitot pressure was developed; the most that could be done was to demonstrate that if there were any such Pitot pressure, it was exceedingly minute in amount, and the more there was, the worse the operation of the torpedo would be. This accounts for a statement in "Exhibit III" describing the construction and operation of appellees' torpedo, namely, that the pressure upon the water and fuel to feed them into the generator chamber is "slightly increased by a Pitot pressure in the pipe G conveying compressed air to the water and fuel tanks" (Rec., p. 32). This, we submit, is wholly inconsequential; if appellee's torpedo is an embodiment of the patented invention, it is a matter of no consequence if the pressure for effecting the feed of the fuel and water by the means disclosed in the patent is augmented in some very slight amount by the Pitot pressure described in this

Sodeau patent. In appellee's torpedo, the static pressure of the air upon the water and fuel effective to feed them into the generator chamber is stated to be "40 or 50 lbs" (Rec., p. 32). If there is any Pitot pressure additional to this, contrary to our belief, it is of trifling proportions compared to that static pressure. The static pressure of 40 or 50 lbs. would suffice to throw a stream of water over a moderate size building, whereas that Pitot pressure would be such a pressure as one might feel if a current of air were directed against the end of his little finger.

Article in "Revista Maritima Brazilieria."

In January, 1908, a Brazilian Naval Officer published in a Brazilian magazine a short general article and a drawing descriptive of the construction of a torpedo devised by an Austrian named Gesztesy, about which the Brazilian officer had been able to collect some meagre information. This article in the Brazilian magazine came to the attention of the U. S. Navy experts on the construction and operation of automobile torpedoes and was sent by them to the E. W. Bliss Company which was then engaged in the manufacture of torpedoes for the United States Navy. It resulted in eliciting from the Bliss Company the opinion that there are "inherent difficulties against the operation of such a system" (Rec., p. 10). In view of this, examination of the article in connection with this suit would seem to be unprofitable.

A reproduction of the drawing of the Brazilian article appears on the sheet opposite page 65 of the record and a translation of the article appears on pages 35, 36 and 37.

Referring to the drawing, the usual compressed air reservoir is shown at A and a pipe *k* leads from the reservoir to a starting valve C and then to a reducing valve D. From this valve D, air at the reduced pressure passes through a pipe k^1, a mechanism I which is not described in the article except that it is characterized as a retarding apparatus, and a pipe k^{11}, and then into an air warming device consisting of a combustion chamber E mounted above a fuel reservoir F. Within the chamber E, most of the air passes upwardly from the inlet end of the pipe k^{11}, through an annular space *d* around a cylinder *t*. A small amount of the air passes through holes *i* in the lower contracted portion of the cylinder *t* and passes upwardly around the outlet ends of ducts *h* leading from the upper end of a pipe *a* which extends down into the liquid fuel in the reservoir F. This air, flowing past the ends of the ducts *h* in the head *g* of the fuel pipe *a*, picks up minute particles of the liquid fuel and forms a combustible mixture which is ignited by the fuse H. The heated air produced by this combustion flows up to the top of the cylinder *t* where it mixes with the larger body of air passing upwardly around the exterior of the cylinder *t*, so that the heated air is diluted and cooled by the unheated air, the whole passing out through the pipe M to the engine.

In addition to these parts, there is a water chamber G from which a pipe *m* leads to a passage *l* surrounding the combustion chamber E, and holes *n* connect this annular passage *l* with the interior of the chamber E around the cylinder *t*. The flow of the air upward through the space *d* and past the openings *n* causes the air to pick up particles of

water issuing through the holes *n*, and these fine particles of water carried along by the cold air mingle with the heated air passing up through the cylinder *t* and assist in reducing the temperature of the heated air, at the same time being vaporized to the form of steam which passes along with the air. Pipes *p* and *o* connect some portion of the retarding apparatus I with the water and fuel reservoirs G and F respectively, so that the upper surfaces of the water and fuel are subjected to air pressure.

The description of this Gesztesy mechanism contains no suggestion that with it any increase in the range of torpedoes may be obtained. Throughout the description, the apparatus is referred to as a "warmer," intended "for warming the air during the course of the torpedo" and the primary feature of the mechanism is stated to be that it

> "enables the engine of the torpedo to preserve all its bronze parts, which is not the case with the English warmer, in which, owing to its temperature, it becomes necessary to use steel in the pistons and distributing valves, so that the preservation of the motor is therefore difficult."

This is the *raison d'être* of this apparatus. With the outside superheater apparatus of the early Sodeau patents like United States patent 835,262, the heated air passing to the engine was so hot as to make it necessary to use steel parts in the engine where bronze parts would have been preferable; and even so, the temperature of the heated air was hundreds of degrees below what it would have been

if all of the oxygen in the air had been utilized for combustion. So this Gesztesy apparatus was devised on the theory that it effected a superior cooling of the hot products of combustion; apparently the production of a greater amount of energy was not contemplated. Also, although some water was introduced into the hot products of combustion and must necessarily have been vaporized, there was no thought of a complete departure from the established practice of using heated compressed air to a new practice of using a motive fluid consisting largely of steam.

Because, in devising this Gesztesy apparatus, there was no thought of developing more energy and generating steam as a motive fluid, the action which takes place within the combustion chamber is radically different from that which takes place in the steam generator of the Davison patent. Only a small portion of the air passing through the inlet pipe k^{11} flows through the holes at the lower end of the cylinder t and picks up liquid fuel from the ducts h. In other words, only a small fraction of the total air passing into the combustion chamber is utilized for combustion with the fuel and the generation of heat. The major portion of the air entering the combustion chamber flows up outside the cylinder t and is utilized for diluting the hot products of the combustion to reduce their temperature. This was a reproduction of the established practice of burning a small portion of the air with fuel and diluting the hot products of the combustion with the remainder of the air, and so long as that practice continued, no substantial increase in the total energy developed was possible.

A further point of difference between the Gesztesy construction and that of the Davison patent

concerns the mode of feeding the fuel and water into the combustion chamber *e*. These liquids are not fed into the combustion chamber by the static pressure of air; the feed is effected as it is in the Sodeau British patent 6081 of 1907, on the principle of an aspirator or atomizer. Instead of the forcible injection of streams of fuel and water into the combustion chamber, the flow of air past the openings *n* and *h* picks up minute particles of the liquid fuel and water and carries them along with the air. Because of this, the Gesztesy apparatus does not comply with the requirement of claim 13 of the Davison patent which specifies that the feed of the fuel and water shall depend "at all times upon the pressure of the oxygen-carrier" instead of upon the velocity of flow of the air past openings through which particles of the fuel and water are supposed to issue.

In all these respects, the Gesztesy apparatus as described in this Brazilian article is radically different from that of the Davison patent. It is quite beyond the limits of reason for one to assume that this article would have furnished sufficient instruction to a worker in the automobile torpedo art to enable him to produce a long range torpedo operating in accordance with the principle of the Davison patent, without the exercise of the prescience of an inventor. In this instance, however, it is unnecessary to speculate upon what would have been done by "the mythical man skilled in the art" because the record shows that this article was brought to the attention of persons skilled in the art who were in no sense mythical, and it shows also that they did not profit by it.

Evidently the Navy Department saw in the Gesztesy article only a disclosure of another type of superheater for it was referred to as a superheater

in the department's letter of April 17, 1908 (Rec., p. 10). Also we have the expert opinion of the engineers of the E. W. Bliss Co., referred to above; they examined the Gesztesy article and concluded that "there were inherent difficulties against the operation of such a system" (Rec., p. 10). Then when the Navy Department proposed some years later to take a license under the Davison inventions, attention was called to this Gesztesy article (Rec., p. 15, par. 4) and the execution of the license agreement immediately thereafter is convincing evidence that the opinion of the article formed by the Department and the Bliss Co. in the early part of 1908 still persisted in the latter part of 1911.

Thus it is quite evident that the Brazilian article failed to convey any suggestion of the Davison invention either to the officials of the Navy Department who examined it or to the engineers of the department's manufacturer of torpedoes whose attention was specially directed to it.

Other Patents.

There are four other patents but discussion of them is unnecessary.

One of them is U. S. patent to Sodeau No. 964,574 (Rec., opposite p. 53). It was not issued until July 19, 1910, over a year after the Davison patent was applied for. It was applied for before Davison's application was filed but that fact alone does not make it pertinent. This, however, is probably unimportant because this U. S. Sodeau patent corresponds almost exactly to the British patent No. 6081 of 1907 heretofore discussed.

Next, there are British and French patents to Gesztesy whose torpedo was partially described in

the Brazilian magazine article (Rec., pp. 53 to 65). These two patents show substantially the same construction as the article and the description contained in them is a little more comprehensive, but they need not be considered for they were not published until after Davison made his invention. It will be noted that Finding XIV (Rec., p. 22), does not place these patents in the art prior to the Davison patent; it merely states that all of the patents and the publication listed in the Finding show the development and state of the automobile torpedo art. We may add that in the proceedings before the Court of Claims there was practically no reference to either of these patents; the expert witness for plaintiff did not refer to them at all and the expert for defendant made only one brief reference to the British patent in connection with one detail which is not adequately described in the magazine article. We recall no mention of them in argument and the dates of drawings showing Davison's priority were established by a stipulation.

Then there is another of the Davison patents covered by the license agreement (Rec., facing p. 66). It issued on the same date as the patent in suit on an application filed at an earlier date. It is the patent referred to on page 14 hereof and it has no bearing on the patent in suit for it does not disclose the system of automatic regulation of air, fuel and water which distinguishes the invention of the patent in suit. Instead, the water and fuel are pumped into the combustion chamber by mechanically-driven pumps, as they are in the DeFerranti patents, a system of operation which experience has demonstrated to be impractical.

Summary.

The Invention.

Among the many matters discussed in the foregoing, some few facts stand out prominently. One of them is that a great improvement in the art of automobile torpedoes was made by someone. For many years the problem of range had confronted the inventors, designers and builders working in this art (Rec., p. 10) and their efforts had carried the art through certain stages of evolution and improvement (Rec., p. 9). But the best their efforts had produced was the outside superheater torpedo with a range of 4,000 yards and that was not good enough. Then came the steam generator torpedo with its range of 10,000 yards and the problem of range was relegated to the past.

So a great improvement was made, and if results obtained from it are at all reliable as an index, that improvement must have been an invention. Also if carrying the art forward by a great stride all at once, as distinguished from a multiplicity of individual small steps, is any index, then the improvement was an invention. And if the existence of many obstacles which had to be overcome before the improvement could be accomplished is any index, again that improvement was an invention, for we know that after the Newport Torpedo Station had experimented for eight months on the development of the steam generator, it had to admit that "the best method of introducing the water has yet to be ascertained," and in its further experimental work, it abandoned the effort to introduce water.

Assuredly it was a great improvement and the production of that improvement involved invention of high order.

THE INVENTOR.

Who made that invention? Davison did. He conceived the idea and developed a workable mechanism, and he disclosed the principles involved and one form in which the invention might be embodied in an application for patent filed in March, 1909; then he demonstrated the success of the invention in attaining its object by applying it to an existing torpedo which, notwithstanding the handicap of a second-hand engine, covered a range of over 6,000 yards, an increase in range of over 50% due directly to his steam generator (Finding XI, pp. 20-21).

Even the meagre record before this Court makes it very clear that the Navy Department recognized that it was Davison who was the inventor. We know that the Department, through its torpedo officer, urged Davison to proceed with his work on the long range torpedo. The one instance of this covered by the present record occurred in July, 1910. (Finding VI.) Up to that time, the Bliss Company had done nothing with water injection except to pronounce that such suggestion of it as appeared in the Gestezy article involved "inherent difficulties." Also at that time when the Department urged Davison to supply the much-desired improvement, the Naval Torpedo Station had just completed eight months of experimentation, had admitted that it had not found the solution and had concluded to discontinue work with water injection.

Then later on, in the fall of 1911, when the steam generator torpedo made by the Bliss Company ran 10,000 yards, the officials of the Navy Department lost no time in getting a license under the Davison

patents. They insisted upon having the license, even though one of their advisers was opposed to it. They insisted upon having it, knowing that the Davison patents covered the water-injection steam-generator torpedo and that the Bliss torpedo which ran 10,000 yards was a water-injection steam-generator torpedo; they knew this for they were told (what they already knew) that the construction covered by the Davison patents was "presumably similar to devices made by other companies" and that the Bliss Company had been "proceeding along the same lines as Davison" (Rec., p. 15).

Probably information of Davison's work was carried from Davison directly to the Bliss Company by the Naval Officer who urged Davison to persist in his work on the steam generator. That would explain the insistence of the Department upon getting a license under the Davison patents immediately after the Bliss torpedo doubled the range of the outside superheater torpedo and before ordering any of the new steam generator torpedoes from the Bliss Company. The torpedo made by the Bliss Company proved that it was a long range torpedo in the fall of 1911 and immediately the correspondence which led up to the license agreement began; and it was not until that correspondence had developed the matter up to the point of submitting the license in its final form for execution by the parties that the Department placed an order for steam generator torpedoes with the Bliss Company.

So it seems clear that it must have been Davison who made the great invention. Who other than Davison could have made it? Could it have been Gestezy, or Sodeau, or De Ferranti? These and various others had proposed, prior to Davison's

work, that water be admitted to the hot combustion products. Because of that, Davison cannot claim the parentage of this idea broadly, that is in whatever form it may be employed, and he did not do so in his patent. What he said in his patent was that this idea would be a most excellent one,

> "provided an apparatus can be devised which is of the requisite simplicity in construction and regulation, so that it may be used without danger and with the assurance that it will be in operative condition whenever it may be called upon to do its work."

Then he proceeded to describe an apparatus of "the requisite simplicity in construction and regulation" having the provision for automatic regulation of the feed of the air, fuel and water into the generator chamber which is an essential requisite of the Davison invention.

The prior workers in the art either were not seeking to develop higher power or else they did not realize how to adapt water injection to the production of higher power; the automatic regulation of the supply of the air, fuel and water, an essential of success, was never achieved by them. They did not get beyond or did not even reach that stage of progress which the Newport Torpedo Station had achieved along in June, 1910, when it reported that "the best method of introducing the water has yet to be ascertained" (Rec., p. 11).

The Revista article on the Gestezy torpedo offered no help whatever toward the solution of the problem. It came to the attention of the torpedo experts of the Navy and the Bliss Company early

in 1908 but the problem of how to attain long range continued to be a problem year after year thereafter. In fact, it made no impression upon the practical art for expert opinion condemned it by pronouncing that there were "inherent difficulties against the operation of such a system."

The Sodeau patent afforded no help. It offered the Pitot tube and an atomizer as instruments for effecting the feed of the fuel and water, but such fuel and water as one could feed with so feeble an instrument as a Pitot tube or an atomizer would not serve to increase range enough to notice it. It is evident that Sodeau was not dealing with the range problem when he suggested the use of the Pitot tube and therefore his patent is irrelevant to the subject under discussion. Moreover, his patent was granted to the firm which owned the patents on the outside superheater torpedo and yet that outside superheater torpedo is the one that was exploited and was recognized as the best available.

So also, the various speculations discussed in the de Ferranti patent afforded no help. De Ferranti's effort, unlike Sodeau's, was directed to increasing range, but that automatic regulation which is so essential to success was not comprehended by him, and his pumps for pumping the supplies of water and fuel into the generating chamber differentiate his proposal definitely from the Davison idea and from the requirements of claim 13 of the Davison patent and from the construction used in appellee's torpedo. His patent, like the Sodeau patent and the Revista article, were available to all workers in the art for years while the experts were seeking the solution of the range problem, but no

one found any help in them; in particular, the Newport Torpedo Station got no help from them and being unable to find the solution in the course of eight months of experimentation, it gave up the task.

So the process of eliminating others also establishes Davison as the inventor.

Infringement.

The only other point that requires consideration is whether appellee's torpedo embodies Davison's invention and here again certain facts stand out prominently.

First, the object of Davison's work in the production of the invention covered by his patent was extending the range of torpedoes and he demonstrated that this object was attained by the employment of the invention. Appellee's torpedo is also a long range torpedo, its range being double that of the outside superheater torpedo which it succeeded.

Second, both appellee's torpedo and that of the Davison patent are distinctive in that a greatly increased amount of power is developed by the injection of water into the steam generator chamber where it is sprayed into the hot products of the combustion of air and fuel and vaporized to form steam which mingles with the gases of combustion and absorbs heat therefrom, thus supplying a motive fluid at high pressure but at a temperature which is within the limits of safety.

Third, the two torpedoes are alike with respect to automatic regulation of the flow of the air, fuel

and water into the generator chamber whereby the proper proportions of these three ingredients are maintained at all times. This is a distinguishing characteristic of the Davison invention; it is "the best method of introducing the water" which the Newport Torpedo Station sought to find through eight months of experimentation and then said it "has yet to be ascertained."

The two constructions are so much the same in this respect that there is exact correspondence between the descriptions of them as given in the Davison patent and in Exhibit III, as appears from the following:

APPELLANT'S TORPEDO DAVISON PATENT Rec., p. 27	APPELLEE'S TORPEDO EXHIBIT III Rec., p. 32
With this construction and arrangement of parts the pressure of the oxygen-carrier in the pipe *e* on the low pressure side of the reducing valve *d* controls absolutely the pressure on the fuel and the pressure on the water supply to the generating chamber, so that the oxygen-carrier, the fuel and the water are fed always at a predetermined pressure to the generating chamber.	The feed of fuel and water into the combustion and generating chamber D is effected by the pressure in the fuel and water tanks of low-pressure air conducted thereto from the low-pressure side of the reducing valve C by the pipe G and its branches H and J, the water and fuel being forced from said tanks to the chamber D through the pipes M and N respectively.

In respect of this major characteristic of the Davison invention to which claim 13 is directed, the two torpedoes are identical. Differences of minor detail involving features covered by other claims of the patent are not pertinent to the present controversy. They occur merely because Davison elected to carry a small supply of water in the torpedo and replenish it from the sea during the run, whereas in appellee's torpedo the supply of water for the whole run is placed within the torpedo before it is launched.

In appellee's torpedo, there is a difference of "40 or 50 pounds" between the pressure on the low-pressure side of the reducing valve and the pressure within the generator chamber. This pressure of 40 or 50 pounds acts directly upon the water and fuel to force them into the generator chamber. In appellant's construction, there is this same difference of static air pressure of 40 or 50 pounds and that pressure acts similarly upon the fuel and water to force them into the generator chamber. It does not act directly upon them as in appellee's torpedo, but indirectly through the flexible diaphragm of the regulator upon the water and through that diaphragm and the water upon the fuel. The two torpedoes are alike with respect to long range, with respect to the development of a large amount of power, with respect to water injection, with respect to automatic regulation of the flow of air, fuel and water into the generator, and with respect to the requirements of every word of claim 13 of the Davison patent.

Therefore, it seems clear beyond argument that the invention of the Davison patent as defined, for instance, in claim 13 is utilized in appellee's tor-

pedo, and that one point we consider to be the only matter at issue in this suit. In fact, since the Court of Claims decided against appellee's argument that its torpedo utilized the Pitot tube of the Sodeau patent and appellee abandoned that contention, it has not been maintained in behalf of appellee that its torpedo does not embody the Davison invention. Yet it is on this point, as well as one can judge from the opinion, that the Court of Claims decided finally against appellant. The Court did not state whether its conclusion was reached as a result of finding that the Davison patent is of limited scope or as a result of finding differences between the two torpedoes which it considered to be of great consequence. It merely announced in its Finding XV that appellee had not used appellant's invention.

The Opinion of the Court of Claims.

No elucidation of the process of reasoning by which this conclusion was reached is found in the brief opinion, notwithstanding the fact that the Court was reversing its former decision and setting aside an opinion (*post*, p. 99) which would have to be recognized, even by one who disagreed with it, as a creditable exposition of views reached by the Court after careful and intelligent consideration of the case.

The new opinion (Rec., p. 23) states that "the Findings of Fact have been amended in important particulars." But the respects in which the Findings, other than Finding XV, were amended, relate only to the license agreement and the correspondence and incidents which led up to it, and insofar as they have any bearing upon whether or

not appellee has used appellant's patented invention, they indicate that it *was* used.

The opinion says that, at most, the license agreement covers the use of the device "covered by Davison's patents or applications" and with that we agree. Then it proceeds to state that

> "Other patents in use and the state of the art convince us that other patentees than Davison, and the Government as well, were experimenting with torpedoes having steam generators at and before the time of the shop license contract."

Very true, but what of it? What bearing has experimentation "before the time of the shop license contract" upon the validity or scope of the patent if that experimentation occurred after the application for the patent had been filed? As to the experimentation of the Government, not only did it occur after the application for the Davison patent was filed, but also it achieved nothing and led eventually to abandonment of water injection.

Then the opinion says that "not only were experiments being made but the Sodeau and other patents in evidence disclose a steam generator." Again, what of it? What we are concerned with here is a steam generator capable of producing greatly increased power and arranged for automatic regulation of the feed of water, fuel and air into the generator chamber so that these three ingredients will always enter the chamber in the proper proportions.

Then the opinion states:

> "The question resolves itself into whether the Government used the plaintiff's device or

> something covered by one of the claims in its patents. We are of the opinion that it did not."

"Did not what?" one might reasonably ask. There is no question as to "whether the Government used the plaintiff's device" if by that is meant the identical thing shown in the drawings of the Davison patent, for we have pointed out differences and discussed them in detail. All we have ever claimed is that what appellee used is so directly equivalent to the construction shown in the Davison patent as to be an embodiment of the invention covered by the patent and defined, for example, by claim 13.

Then the opinion says that

> "the shop license should not be so liberally construed as to prevent the Government showing the exact nature of the device it used and its difference from that covered by the plaintiff's claims."

Certainly the Government should not be prevented from showing such things whether the license be construed liberally or strictly.

Considering the opinion as a whole, the best guess we can make is that the Court of Claims held the Davison patent to be limited in scope so that it covers something less than it would be understood to cover from reading claim 13 and giving its words their commonly accepted meaning. Why it was concluded that the patent must be so limited and what it was held to be limited to are not stated. If they were, more direct reply could be made. Also, if it were stated what the patent was held to

be limited to, it would probably appear that claim 13 was construed as covering precisely the same combination of parts as is specified in some other claim or claims; for instance, if claim 13 were held to be limited to a construction in which the water was drawn from the sea and was used to force the fuel into the generator chamber, it would be the same in substance as claim 2 and Courts have frequently expressed their disapproval of so construing a patent as to hold two claims to be the same in meaning though they must have been solicited and granted on the theory that they were quite different. Furthermore, the Court of Claims once ruled that the patent must be held "to cover any structure that is within the fair meaning of the language of any of its claims" and cited authority for this conclusion (*post*, p. 103), but its final opinion seems to express a diametrically opposite view for which no authority is offered; the Court even said that if defendant's structure was "within the reasonable and fair meaning" of the claims of the patent, "then, certainly, the plaintiff should be compensated in accordance with the terms of the contract" (*post*, p. 103), but this self-evident truth must have been held later to be either untrue or inapplicable, though which is not stated.

This appellant or any other citizen of the United States who goes into a Court of the United States in good faith with a claim for relief which it believes to be just, is entitled, or has always been assumed to be entitled, in case its claim for relief be denied, to some indication of the reasons for the denial. In this instance, however, appellant is before this Court on appeal unable to state why its claim was denied beyond what appears in the two lines at the end of Finding XV, though it

knows that the claim was not denied because of any matter brought out in testimony taken subsequent to the allowance of the claim or because of any matter presented by appellee in its brief and argument submitted subsequent to that allowance.

Conclusion.

This appellant devoted years of effort and very large expense to devising an improvement for which there was a great need in the Navy of the United States and it was urged to do so by officers of the United States Navy who felt so keenly the need for the improvement. Moreover, its effort was successful and its success was demonstrated in convincing form. At the end of all of this experimental work, what appellant had, representing its long-continued effort and its considerable investment, was patent rights for inventions developed in the course of the work. These patent rights the Navy Department wanted and it got them by the very direct method of purchasing them from the owner by contracting to pay an agreed price. When appellant entered into that license agreement, it gave to the Navy Department practically all it had in the field of automobile torpedoes; with the Department the only purchaser of such torpedoes made in this country, the non-exclusive license which appellant gave is the equivalent of an assignment. So appellant gave up all it had in the torpedo field, all the assets it had acquired by the efforts of its technical staff and its considerable investment, relying upon the obligation covered by the contract to pay the agreed price. But its reliance has so far proven

to have been misplaced and it is dependent upon this Court to obtain the payment which should have been made years ago without so much as a request for it.

Respectfully submitted,

FREDERICK P. FISH,
WILLIAM H. DAVIS,
DEAN S. EDMONDS,
Counsel for Appellant.

New York, N. Y., December 20, 1923.

APPENDIX.

Opinion of United States Court of Claims.

Filed April 5, 1920.

Withdrawn November 15, 1920.

CAMPBELL, Chief Justice, delivered the opinion of the court:

The plaintiff alleges that it made an agreement with the Government, in accordance with which the United States was licensed and empowered to manufacture, on its own behalf, and to use, "automobile torpedoes equipped with steam generators containing the inventions" set forth in certain letters patent, and in certain applications for letters patent, and attaches to its petition a copy of the agreement. The Government agreed to pay a substantial sum for each of the torpedoes made and accepted in accordance with the license, and containing the inventions set forth in the letters patent and the applications for letters patent enumerated in the agreement. The fact that the action is based on this agreement removes some of the questions that would arise if the defendant were being sued for an infringement.

In the *Harvey Steel Company case,* 196 U. S., 310, it is said:

> "The court has not entered upon an examination of the patent; of the construction which should be given to it; of the state of the art, or of any of these questions which would properly be subjects of consideration, if this were an action for an infringement."

The position thus taken by the court in the Harvey Steel Company case may not be assumed, in its entirety, in the instant case, because in that case the contract dealt with a process "known as the Harvey process," but it is to be observed that the court emphasized the fact that the parties assumed that the process used, and intended to be used, was covered by the patent.

What the parties were concerned with in the contract in question will more clearly appear from the history of automobile torpedoes stated in the findings of fact. The general practice in the propulsion of automobile torpedoes for many years had been to use compressed air for the motive power, and, at the time of the Davison invention there had been an evolution through several stages as follows: First, the use of cold compressed air, from a compressed air storage chamber, through a reducing valve to the propelling engine. This was followed by the use of what was called the "inside superheater," which consisted of a burner located within the compressed air storage chamber for heating the air therein during the run of the torpedo. Then came what was called the "outside superheater," which was a combustion chamber located in the conduit for carrying the air from the storage reservoir to the engine, and arranged to have liquid fuel admitted to, and burned within, the chamber for the purpose of heating the air prior to its admission to the engine.

The automobile torpedoes in use by the United States Navy in the years 1907 and 1908 were of the type having the "inside superheater," and had a range of about 3,000 yards. In 1909 the Navy obtained torpedoes that were equipped with the

outside superheaters and attained a range of about 4,000 yards. With no greater range than this, the automobile torpedo had come to be regarded as a weapon of limited utility. The development in battleships, and their long-range armament, would tend to keep hostile vessels too far apart for a torpedo, with a limit of range of 3,000 or 4,000 yards, to be of any great or real efficiency. The desire, therefore, and the efforts of naval officers studying the question, were directed toward some method for producing a greater range. The efforts of Gregory C. Davison in that direction resulted in a fourth stage in the evolution of the automobile torpedo, namely, by the use of a steam generator to produce a new motive fluid for the engine which propels the torpedo. This steam generator was a chamber located on the low-pressure side of the reducing valve in the conduit for conducting the compressed air from the storage reservoir, and was arranged to have fuel and water admitted to the chamber under a reduced pressure of the air or oxygen carrier. The fuel was ignited and a large part of the oxygen burned and the water, admitted as stated, was converted into steam by the hot products of the combustion. This steam, with the gases of combustion, was made to constitute the motive fluid for the engine. Broadly speaking, the motive fluid thus became steam instead of cold or heated air, as in the former stages.

By the use of the steam generator the range of automobile torpedoes was increased to about double the range attained by the use of outside superheaters, which, as has been said, had improved the range over that attained by the inside superheater. In other words, the new method increased the range

to about 7,000 yards, while the range of the torpedoes using the superheaters had been 3,000 to 4,000 yards.

There can be no doubt that Davison was the first to make practical use of steam and the gases of combustion combined as the motive power for these torpedoes. He demonstrated their utility for that purpose. The much-desired result of a largely increased range was accomplished with the advent of his invention. This steam generator was something new. It marked a decided departure from the practice theretofore obtaining in its substitution of steam for heated air. It increased the volume of the motive fluid and provided a means of cooling it, so that its use would not destroy the efficiency of the engine it was intended to drive. Mr. Davison had assigned his rights to the plaintiff in certain letters patent, and applications therefor, relating to his invention, and it is hence recited in the agreement upon which this action is based that the plaintiff "is the owner of the invention known as steam generator for automobile torpedoes covered by" certain applications for patent. The patents had not been issued, nor could the parties to the agreement know, with exactness, what of the claims in the applications would be allowed to pass to patent. The defendant, admitting the fact of the "invention known as steam generator for automobile torpedoes," joins in the recital that it was "desirous of securing certain manufacturing rights with respect to said invention."

In these circumstances a question raised by defendant, in defense of the action, is whether the claims in the letters patent, issued upon the applications mentioned, are to be narrowly construed, as

the defendant urges they should be, or whether they are entitled to a liberal construction.

It is doubtless true that the claims in the patent, as issued under the applications therefor, must be considered in order to determine whether the defendant has made use of the invention referred to in the agreement; but in giving them consideration the court is not justified, by the facts of this case, in so narrowly construing them as to make an invention worthless, which was recognized by the parties themselves to be valuable. (See *Alvin Co.* vs. *Scharling,* 100 Fed., 87.) On the other hand, the inventor, or his assignee in this case, is entitled to such a construction as, having in view the intention of the parties to the agreement, will allow the patent to cover any structure that is within the fair meaning of the language of any of its claims. *United Printing Machinery Co.* vs. *Cross Paper Feeder Co.,* 227 Fed., 600, 602.

The action is not for an infringement, but seeks to recover royalties which defendant agreed to pay for the right to manufacture and use an invention which it was desirous of using. If the defendant's structure, designed and used to accomplish the result which Davison's invention first made possible and produced, and which defendant's officers had been striving for, was within the reasonable and fair meaning of claims in the applications as subsequently allowed, then, certainly, the plaintiff should be compensated in accordance with the terms of the contract. The defendant insists that each of the claims relied on by plaintiff is a combination claim, and that a patent for a combination does not cover a particular device unless all of the substantial features of the combination are

present or used. With this statement of the general rule we need not take issue. But the strictness of construction to be given the claims, and the substantial features of the combination, when the question of infringement is the issue, yields to the more liberal view that is to be taken of the claims when the defendant has admitted the validity and utility of the invention and has contracted for its use. *Harvey Steel Company case,* 38 C. Cls., 662.

The defendant's officers quickly recognized that Davison's invention was of great utility, and were desirous of using it. That invention comprised a steam generator to produce a motive fluid for automobile torpedoes. The inventor in his specifications declared he "had invented certain new and useful improvements in apparatus for generating motive fluid for automobile torpedoes," and pointed out that it would be "a great advantage to substitute for compressed air, commonly used as a motive fluid, a motive fluid derived by burning a suitable fuel with compressed air or oxygen, and then injecting into the highly heated products of combustion a quantity of water, whereby the water is converted into steam, adding to the volume of the fluid and reducing its temperature." "In this way," it was said, "there may be formed a motive fluid, under extremely high pressure and at moderate temperature, which is admirably adapted to the operation of the light, high-speed, powerful engines which are used on such torpedoes." The object of the invention was to provide an apparatus suitable for that purpose. The invention for which defendant contracted was the steam generator. The letters patent had not issued

and applications for them were pending. The central idea present in the specifications, and in the contract as well, is the steam generator. As was said by Judge Booth in *Societe Anonyme case,* 43 C. Cls., 25, 59: "It is the invention; without its presence the device fails; with it the device succeeds. The details of construction are of minor importance." The details of construction must have been given small consideration by the parties to the contract in this case, because, as has been said, the applications had not passed to patent when the contract was made. Can it be doubted that if the plaintiff were suing for an infringement the license agreement would furnish a complete defense?

The claims in the patent which are relied on are 1, 5 and 13. These claims, with the specifications, are supposedly addressed to those skilled in the particular art and require only such precision as is required to enable that class of persons to use the invention. (*Loom* vs. *Higgins,* 105 U. S. 580.) Unquestionably, these could not fail to recognize that the essential, the functioning element of the device, was a steam generator.

These claims are severally attacked by the defendant, and, giving to them the narrowest possible construction, it is sought, not only to make them practically meaningless, but also to make it appear that the Government device differed from that described by plaintiff. It is not to be assumed that the Government, after contracting for the use of an invention, not then patented, would seek by mere change of some unessential details to use the thing it had contracted for and escape the obligations of its contract.

The specifications and claims of the plaintiff's patents and the construction of defendant's device are shown in the exhibits to the findings. Without discussing these in detail it is sufficient to say that we are satisfied that the Government's device fulfilled all the material or essential requirements of claim 13. That the Government construction included a generating chamber for generating motive fluid for automobile torpedoes can not be, and is not, denied. In that chamber air, or an oxygen carrier, and fuel are burned, and the products of that combustion are mixed with water vapor. Thus air is supplanted by steam as a motive fluid, with the advantages of which we have spoken. That construction also includes a tank for the compressed air, spoken of in the claim as a tank for the oxygen carrier under pressure. It has the conduit through which the compressed air from the tank reaches the generating chamber when the control valve is open. It has the water and fuel supply. It has a second conduit, also controlled by the control valve, through which the air, or oxygen carrier, pressure is applied to the fuel and water. It provides for carrying the water and fuel under said pressure into the generating chamber, whereby their feed depends at all times upon the pressure of air or oxygen carrier. The generating chamber used by the Government, if not identical with, is clearly the mechanical equivalent of that described by Davison. The narrow construction of the claims contended for by defendant is not to be tolerated in an action on a contract made in the circumstances shown in this case. The action is not for an infringement, as was the fact in most of the cases cited by defendant. Having contracted

for plaintiff's device, and used it, the defendant should respond in accordance with its contract.

The amount it should pay is ascertainable from the number of torpedoes manufactured and accepted for defendant's use containing the plaintiff's device. The evidence upon this question was not taken because it was agreed that the question of liability would first be settled. The court decides that the Government is liable, and the case will be remanded for proof as to the amount of the liability. And it is so ordered.

Graham, Judge; Hay, Judge; Downey, Judge; and Booth, Judge, concur.

INDEX.

AUTHORITIES CITED.

In the Supreme Court of the United States.

OCTOBER TERM, 1923.

ELECTRIC BOAT COMPANY, APPELLANT,
v.
THE UNITED STATES.
} No. 159.

CHRONOLOGICAL SYNOPSIS OF PRINCIPAL POINTS OF THE FINDINGS OF FACT.

(Dates referring to activities of Davison and of Electric Boat Company in italics, to activities of E. W. Bliss Company in bold-face type.)

August 17, 1905.

De Ferranti British patent 9496 of 1904 (Exhibit C 5) published (Finding XIV, p. 22) with complete exposition of operating a torpedo power plant by burning all possible fuel with air or oxygen and injecting water both to cool the products of combustion and to add to their volume by producing steam.

November 6, 1906.

Sodeau United States patent 835262 (Exhibit C 7) granted (Finding XIV, p. 22) disclosing feeding liquid into the combustion chamber of the superheater of a torpedo power plant by displacing it by a portion of the compressed air under a differential in pressure.

January 1, 1908.

Mr. Davison resigns from the Navy and enters employ of plaintiff. (Finding III, p. 9.)

January, 1908.

Article in "Revista Maritima Brazileira" (Exhibit C 14, p. 22) published, describing power plant of Gesztesy torpedo, "which power plant provides for the generation and use of steam in combination with compressed air and the gases of combustion for motive power." (Finding V, first paragraph, p. 10.)

Jan. 27, 1908.

Sodeau United States patent application which resulted in United States patent 964574 (Exhibit C 11), equivalent to British patent 6081 of 1907 mentioned below (Exhibit C 10) filed. (Finding XIV, p. 22.) This patent describes the plan of construction of the torpedoes complained of in this suit.

March, 1908.

Bureau of Ordnance receives Revista article. (Finding V, first paragraph, p. 10.)

March 26, 1908.

Bureau of Ordnance forwards Revista article to E. W. Bliss Company. (Finding V, 2nd paragraph, p. 10.)

April 4, 1908.

The Bliss company returns Revista article and states that it had for some time "had plans on the same general principle as that shown" and that it intends at as early a date as possible to make certain tests of it. (Finding V, 2nd paragraph, p. 10.)

April 17, 1908.

Bureau of Ordnance request that the Bliss Company inform it of any experiments which the Bliss Company might make with superheater of Gesztesy type. (Finding V, 3rd paragraph, p. 10.)

April 23, 1908.

Sodeau British patent 6081 of 1907 (Exhibit C 10) published (Finding XIV, p. 22), showing torpedo power plant with both water and fuel injected into the combustion chamber by displacing them by portions of the compressed air under a differential in pressure. This patent describes the plan of construction of the torpedoes complained of in this suit.

June 9, 1908.

The Bliss company replies to Bureau's letter of April 17, 1908, stating that it had as yet made no progress with experiments as its testing facilities were so fully occupied with torpedoes under way for the Bureau that it could not then conduct any outside experiments and that it would report to the Bureau the result of any experiments it should make. (Finding V, 3rd paragraph, p. 10.)

December 19, 1908.

Gesztesy French patent 393,324 (Exhibit C 13) published (Finding XIV), this patent being for the power plant of the Gesztesy torpedo described in the Revista article (Exhibit C 14) referred to above. (Finding V, first paragraph, p. 10.) The corresponding British patent 18,241 of 1908 (Exhibit C 12) was published March 3, 1909.

1909.

Navy obtains torpedoes with outside superheater type of power plant. (Finding IV, p. 9.)

March 29, 1909.

Application for patent in suit filed. (Finding II, p. 8.) This application was not seen by the Bureau of Ordnance prior to the date of the contract in suit, April 2, 1912. (Finding X, last paragraph, p. 20.)

November, 1909.

Bureau of Ordnance commences experiments at Naval Torpedo Station at Newport for increasing the motive power and range of torpedoes by the use of steam generated by the injection of water into the combustion chamber where the steam was combined with the compressed air and gases of combustion. (Finding V, 4th paragraph, pp. 10–11.)

June, 1910.

Bureau of Ordnance receives comprehensive written report on work at Naval Torpedo Station at Newport. (Finding V, 4th paragraph, pp. 10–11).

1910.

Verbal information received by the Bureau of Ordnance from the Bliss Company with reference to experiments by the company along the same lines. (Finding V, next to last paragraph, p. 11.)

July 26, 1910.

Commander Norton, the Bureau of Ordnance officer in charge of torpedo work, visits plaintiff's plant for the purpose of inspecting air compressors

and gyroscopic control gear. Told by Davison the progress of experimental work, but not shown any of the component parts of the apparatus used. Norton requested Davison to *take up* the matter *again*. (Finding VI, p. 11.)

August 8, 1910.

Electric Boat Company proposes that Government enter comprehensive license agreement, to be contingent on, but obligatory after, a successful demonstration, the proposed license involving a cost-plus basis of manufacture, an initial payment of $100,000 and large royalties. (Finding VII, p. 12.) This proposition was not accepted but instead—

September 6, 1910.

The Bureau of Ordnance, with a view to determining the merits of the different motive-power systems, addresses substantially similar letters to E. W. Bliss Company and to Electric Boat Company inviting proposals for making experimental torpedoes, each company being informed that the torpedo constructed by it would be placed in competition with a torpedo to be submitted by another firm and with torpedoes being developed by the Bureau itself. (Finding VIII, first paragraph, p. 13.)

October 14, 1910.

Bliss Company in letter to Bureau refers to tests already made by injecting water giving practically double the amount of work previously obtained. (Finding V, last two paragraphs, p. 11.)

January 17 and 23, 1911.

Contracts with Electric Boat Company for experimental torpedoes of 18 and 21 inch sizes executed. (Finding VIII, first paragraph, p. 13.)

February 16, 1911.

Contracts with Bliss Company for experimental torpedoes of 18 and 21 inch sizes executed. (Finding VIII, p. 13.)

August, 1911.

Bliss 21-inch torpedo, a "practical duplicate" of those complained of in this suit (Finding XIII, 3rd paragraph, p. 22) completed (Finding VIII, 2nd paragraph, p. 14), tested in the fall, accepted and paid for on the basis of having obtained a range of 10,000 yards, the contract providing for a bonus for excess performance above the 4,000-yard run. (Finding VIII, first two paragraphs, pp. 13–14.)

September 24, 1911.

Government has Bliss 21-inch torpedo on testing range at Sag Harbor and torpedo had made run of over 9,500 yards. (Finding IX, last paragraph, p. 16.)

October 20, 1911.

Electric Boat Company submits drawing of device of form and character shown in Exhibit I (Finding XI, first and last paragraphs, pp. 20–21) to be applied to existing Whitehead torpedoes to double their range with proposition for royalty to be paid "on all torpedoes fitted with this device in the future." (Finding IX, p. 14.) At this time the Government

possessed a large number of Whitehead torpedoes of 4,000 yards and under range. (Finding IX, first paragraph on p. 15.)

October 23, 1911.

Bureau of Ordnance forwards Electric Boat Company's letter to torpedo station for comment. (Finding IX, p. 15.)

October 26, 1911.

Commander Williams, in charge of torpedo station, recommends that Electric Boat Company's proposition be not accepted since the Bliss Company's torpedo, a "practical duplicate" of those complained of in this suit (Finding XIII, 3rd paragraph, p. 22), with a superheater in which was injected water, was already in the water and the torpedo station itself and foreign companies were working with a superheater in which water was injected. (Finding IX, p. 15.) The Bliss Company torpedo had as early as Sept. 24, 1911, run 9,500 yards. (Finding IX, p. 16.)

November 2, 1911.

Replying to torpedo station, Bureau of Ordnance indorses on Electric Boat Company's letter of October 20th that Electric Boat Company's proposition is to replace superheater in old torpedoes with Davison steam generator, that "the Bureau is given to understand this generator is not in any sense a superheater" and "is not to conflict with present superheater rights." (Finding IX, pp. 15–16.)

November 4, 1911.

Commander Williams recommends that no contract be entered into until "it is clearly established that this device is different from other patented devices of the same nature" but recommends loaning torpedoes to Electric Boat Company in order that this device may be installed therein for test. (Finding IX, p. 16.)

November 9, 1911.

Bureau of Ordnance answers Electric Boat Company's letter of Oct. 10, 1911, proposing royalty "for all torpedoes converted" and fixes 6,000 yards as minimum performance. (Finding X, p. 16.)

December 6, 1911.

Electric Boat Company answers Bureau's letter of Nov. 9, 1911, royalty to apply "not only to torpedoes which may hereafter be converted but also to torpedoes which the Government may build at its own works and in which the *device in question* is to be used." (Finding X, pp. 17–18.)

December 13, 1911.

Bureau of Ordnance makes requisition for two Whitehead torpedoes to be converted by Electric Boat Company and at the same time forwards Electric Boat Company blank shop license in which Electric Boat Company is to insert the numbers of patent applications. (Finding X, p. 18.) The patent applications were not seen by the Bureau. (Finding X, last paragraph, p. 20.)

January 18, 1912.

Bureau of Ordnance preparing contract for fifty Bliss torpedoes having power plants like the 21-inch Bliss torpedo (Finding VIII, 3rd paragraph, p. 14), a practical duplicate of those complained of in this suit. (Finding XIII, 3rd paragraph, p. 22.)

April 2, 1912.

Contract in suit executed. (Finding X, p. 19.) This is essentially the blank shop license forwarded Dec. 13, 1911, with the numbers of the patent applications inserted by the Electric Boat Company. The patent applications were not seen by the Bureau of Ordnance prior to the execution of the agreement. (Finding X, last paragraph, p. 20.)

May 15, 1912.

Bliss Company's second experimental torpedo (18-inch size) formally accepted by the Government after exceeding contract requirements. (Finding VIII, 2nd paragraph, p. 14.)

June, 1912.

Government lets contracts to the Bliss Company for manufacture of 290 torpedoes having power plants similar to the 21-inch torpedo (Finding VIII, paragraph 3, p. 14), a practical duplicate of those complained of in this suit (Finding XIII, paragraph 3, p. 22), the torpedo which as early as Sept. 24, 1911, made a run of over 9,500 yards on Government testing range at Sag Harbor (Finding IX, last paragraph, p. 16).

August 20, 1912.

Patent in suit 1,036,080 is granted. (Finding XII, p. 21.)

October, 1912.

Electric Boat Company completes 18-inch torpedo under contracts of Jan. 17 and 29, but this torpedo never met the minimum requirement of the contract for the range of 4,000 yards. The 21-inch torpedo was never completed. (Finding VIII, last paragraph, p. 14.)

November, 1912.

Converted Whiteheads completed and sent to torpedo station by Electric Boat Company for test. (Finding XI, p. 20.)

September 27, 1913.

After a long period of experiments at the torpedo station one of the converted Whiteheads exceeded on one occasion the minimum run of 6,000 yards, a 50% increase over their original range, required for acceptance, and the Naval Torpedo Board reports that "the reliability of this form of steam generator has not been established and * * * there are grave doubts as to the practicability of this device as at present fitted for service use" and recommends "that no steps be taken toward the conversion of service Whitehead torpedoes into steam torpedoes of this modification." (Finding XI, p. 20.)

October 6, 1913.

Bureau of Ordnance approves company's bill of $3,000 for the conversion of two Whitehead torpedoes, which bill was thereafter paid. (Finding XI, p. 20.)

June 16, 1914.

Electric Boat Company's contracts of Jan. 17 and 29, 1911, for experimental torpedoes cancelled at said company's request without penalty. The 21-inch torpedo had never been completed and the 18-inch torpedo failed to meet the minimum requirement of the contract for a range of 4,000 yards and was therefore not accepted by the Government. (Finding VIII, 4th paragraph, p. 14.)

BRIEF FOR DEFENDANT.

May it please the Court:

ERRORS IN APPELLANT'S STATEMENT OF FACTS OF THE CASE.

The brief filed for appellant abounds in statements which either find no basis at all in the record, but represent appellant's idea of what the evidence to support his contentions should be, or else are unwarranted by the Findings of Fact on the subjects referred to. These statements are so numerous and so glaring that we can not entirely pass them by. We refer to them here before proceeding to our own statement of the case lest we seem to assent to their correctness, but a clear understanding of their inaccurate and misleading character can be had only from the fuller treatment of facts in the main body of our brief. We mention only a few and will not attempt to treat them in logical order, but simply one after another as they may be noted by a cursory glance through the brief.

In the beginning, on page 2, there is a statement that in the Davison form of power plant the motive fluid supplied to the engine "consists largely of steam." This has no foundation in the record and is denied. It is simply an attempt to call all the present types of torpedoes "Steam Generators" and to try to bring them within the purview of the peculiar trade name which, at the time of the contract in

suit, was applied to Davison's particular device, and to that alone. Connected with this is the attempt to show that Davison was the first to conceive of burning all the oxygen in the air tank of the torpedo. On page 19 we are told that he "discovered" that not all the oxygen was burned in the outside superheater—a discovery of something which everyone knew—and on page 20 that he "reasoned from this" that greater power could be obtained by utilizing all the oxygen. This also everyone knew, and De Ferranti had not only pointed out the fact in his patent published in 1905 but pointed out that the way to attain the desired results was to introduce water so as to make the heat units effective by the production of a larger volume of motive fluid at a lower temperature (see in this brief, p. 98 ff.). That there is no credit due to Mr. Davison for any idea of this kind may be clearly seen from the fact that in the patent in suit no single word is said about burning all the oxygen of the air, although that is held up again and again throughout the brief as a paramount feature of Davison's alleged invention.

Throughout the brief, particularly on pages 3 and 21, we are told that Davison's was the first torpedo mechanism making use of steam, and that his invention changed failure into success. The Bliss torpedo, built on the plan of the Sodeau patents, was successfully running in September, 1911. (Finding IX, p. 16, last paragraph.) Of four torpedoes constructed by Mr. Davison three were complete failures, and one

on a single occasion showed a moderate increase in range, but was estimated as a failure by the report of the Torpedo Board which considered its merits. The single successful run was at some time after November, 1912. (Finding VIII, p. 14, last paragraph and Finding XI, p. 20.) Evidently appellant feels it necessary to apologize for the performance of its one torpedo, because we are told (brief, pp. 15–16), without warrant in the record, how much further it would have gone if the engine had been a new one. We may point out that the torpedo which Davison built with a new engine never attained even the minimum range. (Finding VIII, p. 14.)

In many instances through the record, pages 4, 23, 85, 86, and 90, it is said that the Navy abandoned its own experiments on water injection because they could not discover a successful way to introduce the water. This statement is incorrect. As the report of the Navy's experiments reproduced on page 11 of record states, the effort was made "to produce a torpedo better than the best for present needs," and that "until there is produced a torpedo entirely reliable in all those functions of the details which have *nothing to do with the heater*, it is proposed to use seventy-five per cent alcohol and no injection of water." The work was not abandoned. The emphasis was for a time shifted, but the letter quoted on page 15 of the record shows that in 1911 the work had been taken up again and was near completion, when the complete success of the Bliss torpedo rendered further

development unnecessary. In this same connection it is interesting to note that Davison himself never devised any method of injecting water which was practical for use, much less the "best" method.

The situation of the Navy Department at the time of the contract is misrepresented throughout the brief, both by unwarranted statements as to facts and by statements contrary to the record. Perhaps the most flagrant example is the scandalous statement on page 87 that Naval officers violated professional confidence and carried information of Davison's work directly to the Bliss Company. The court would be well warranted in striking from the record such a statement. Not only has it no foundation in the record, but we show elsewhere (p. 127) that the facts of the record refute it. The allegations on pages 5, 56, and 57 that the Navy entered into the contract to protect it in the use of the Bliss invention, knowing that Davison's patent covered it, are refuted on pages 63–68 of this brief. These allegations are supported in appellant's brief by unwarranted statements. For instance, on page 64 it is stated that the Navy knew of Davison's invention. As a matter of fact, as Finding VI shows, the officers of the Navy knew none of the details of what Davison had done. It is stated on page 3 that Davison kept in touch with his former associates of the Navy and that they were "constantly informed of the progress of his work." No finding substantiates this.

On page 57, after reciting that the Navy Department contracted with the E. W. Bliss Company and the plaintiff company for the manufacture of "experimental torpedoes" appellant goes on to say: "Appellant's torpedo, as we have stated above, attained a range of 6,000 yards, 50 per cent greater than the previous superheater torpedoes." This is false. Appellant's experimental torpedo was a flat failure and was unable to reach even the minimum range of 4,000 yards. (Finding XIV, p. 14.) It was a Whitehead torpedo, one of two reconstructed by appellant under an entirely different contract, which years later "after a long period of experiments" made "on one occasion" a run of 6,000 yards. (Finding XI, p. 21.) This single solitary run of a lone torpedo only emphasizes the otherwise consistent failure which attended appellant's efforts.

On page 84 reference is made to drawings as "showing Davison's priority." If they had, the Court might have included a reference to such priority, or at least to such drawings, in its Findings. They are not referred to in the present record and should not be referred to in the brief.

The entire discussion of the history of torpedoes, of the patented device, and of the patents of the prior art abounds in statements, many of which find no foundation in the record, which are properly matters of expert opinion and many of which we can not accept. It is possible to refer only to examples. For instance: On page 33 the entire theory of how a differential pressure is created in the Davison tor-

pedo is something outside of the patent itself and outside the findings of fact. On page 92 the statement that Davison carries some water in his torpedo is not warranted by the patent, and seems, in fact, contrary to the disclosure. The theory of operation set forth on page 22, the discussion of Sodeau patents on pages 69ff, and of the Gesztesy device on pages 78ff are further instances of *ex parte* expert argument, having no foundation in the record. The theory with respect to the Sodeau patent, 6081 of 1907, and with respect to Gesztesy, that no increase in energy was contemplated, is an absurd argument. There was no need for the patentee, Sodeau, to state that he could burn all the oxygen in the air. That was an old idea and had been disclosed by De Ferranti. He did say that he would increase the volume of working fluid passing to the engine. (Addition to Rec. p. 50.) The appellant's statement that he merely designed to cool the gases of combustion for the mere sake of cooling is silly. Energy is a function of temperature and volume. The only reason for cooling is when the temperature is excessive. Water may be added to cool and the volume increased with a greater energy than would be possible at the lower nonexcessive temperature which would otherwise be possible. The finding of the court below that the defendant does not use the Davison device, and the statement in its opinion that Sodeau and the other patents disclose steam generators sufficiently indicate that it considered

any conflicting testimony on these points of thermo-dynamics and resolved them against the contentions which appellant now again advances in his brief without any warrant therefor in the record before this court. The fact is that the Government utilizes the thermo-dynamic theory of De Ferranti and the apparatus of Sodeau and has a long-range torpedo. Davison utilized the theory of De Ferranti and his own patented apparatus and the result was a failure.

Another instance where the theoretical contentions of appellant in the Court below are advanced here without warrant from the record is the often-repeated assertion (brief, p. 45) that the Government's torpedo embodies a principle of Davison's invention because the rate of feed is regulated in accordance with the pressure of the air to preserve the proportions of fuel, water, and air. As we show elsewhere (*infra*, p. 124) this may be true of the patented device, but no such regulation is present in the Government torpedo. Appellant's contention may not be advanced on this record. On the contrary, the question clearly has been decided and is concluded by the finding of fact that defendant does not infringe.

On page 7 it is said that the drawing of the device on which the contract is based is not referred to in the Findings of Fact. The first and last paragraphs of Finding XI, page 20, clearly identify Exhibit I, page 24, as a representation of the "device in question."

The statement on pages 77 and 7 that the defendant in the second trial in the Court below abandoned its contention that its torpedo operated in accordance with the Sodeau invention, expanded on page 93 to the still more extraordinary allegation that defendant abandoned the contention that its torpedo does not embody the "Davison invention," is not supported by the record and is not true. The second, third, and fourth of our present contentions as listed hereafter were those presented to the Court.

Indeed, the appellant throughout gives much greater attention to its own unsuccessful contentions in the Court below than it does to the record which that Court has certified on this appeal. Thus it prints as an appendix to its brief the former opinion of the Court of Claims which the Court in view of "additional evidence," causing amendment of the findings of fact "in important particulars," vacated and set aside and on page 6 of its brief praises the cogency of this opinion, concededly based on an incomplete presentation of the facts of the case.

As shown by the opinion of the Court on the defendant's motion for a new trial, reported in 55 C. Cls. 497, a new trial was granted under Section 175, Judicial Code, to prevent "fraud, wrong, or injustice" to the United States. Further evidence was taken and it seems that appellant is ill-advised to present to this Court the opinion of the Court below based on an incomplete record and repudiated by that Court

when, after consideration of the entire testimony, the Court reached a conclusion entirely different as to the achievements of the patentee in the art, the scope of the patent, the pertinency of the prior art, and the scope of the contract.

The absurd character of the plaintiff's claim when presented in the light of full evidence is strikingly accentuated by its curt dismissal on the second and full trial with *per curiam* opinion.

In conclusion we may point out the absurdity of appellant's extensive argument as to the disclosure of the patent, its minute analysis of the words of a claim in that patent, and its contention (p. 53) that defendant is estopped to question that analysis of the meaning of those words, when the brief admits (p. 65) that "the purpose of the license agreement was to secure to appellee the right to use the *steam generator devised by Davison regardless of any question* either as to validity of patents he might obtain or *as to the scope of their claims.*" (Italics ours.)

BRIEF OUTLINE OF CASE.

This is a suit on a contract in which the plaintiff seeks to collect from the United States a royalty payment with respect to automobile torpedoes such as are launched from submarines, torpedo boats, and aeroplanes by the United States Navy. If the contention of the plaintiff is sustained, the United States must pay the plaintiff the sum of eight hundred dollars ($800) for each and every torpedo of

the present standard type used by it in the past, and the sum of eight hundred dollars ($800) for each and every such torpedo which will be used by it for many years to come. It is a matter of common knowledge that the United States in the late war, relatively speaking, used few torpedoes, and yet the total amount involved as royalties up to the present time is measured in millions of dollars. The contract has many years to run. If the United States during those years should be engaged in warfare and should be called upon to use torpedoes as freely as our enemies or even our allies used them in the World War, the amount involved will be simply staggering. This is no reason why the Government should not be required to live up to the terms of the contract; but it is a sufficient reason why the Government should ask for a patient hearing on the merits and the law.

The contract (record, p. 19) recites that the petitioner is "the owner of the invention *known as Steam Generator for Automobile Torpedoes* covered by" certain applications for patent, and licenses the United States to use and have made for it the device then "known as Steam Generator for Automobile Torpedoes" on the payment of a specified royalty for each torpedo "equipped with the Steam Generator for Automobile Torpedoes." One of the patent applications referred to has since the date of contract matured as a patent and this patent will be referred to as the "patent in suit," although the

suit is not literally a suit on the patent. This patent was granted on an application of Gregory C. Davison, a former naval officer and the vice president of the plaintiff company, and bears the number 1,036,080. It is reproduced in the record, page 25.

The contract on its face thus refers by name to a certain device "known as Steam Generator for Automobile Torpedoes," said to embody various features of construction on which several patent applications then pending in the Patent Office were based. It was an invention in the sense of something which had been invented, a physical thing and, as will later be shown, was known to the parties at the time of the contract as a definite physical thing, represented only by a drawing or blue print.

The contract, as will be more fully shown in the course of this brief, was entered into at a time when the plaintiff undertook to install this particular physical thing, christened by the plaintiff a "Steam Generator for Automobile Torpedoes," the device of a drawing submitted by the plaintiff, in two old Whitehead torpedoes owned by the United States. It was anticipated that, if this installation or conversion of the old torpedoes was successful, a field of usefulness for the device would be opened up and other similar installations would be required. The license contract in suit was designed to empower the Government to complete these prospective additional installations. As a matter of fact, the United States has never made any further installations of the Davi-

son "Steam Generator for Automobile Torpedoes." The efforts of the plaintiff to improve the power plants of torpedoes were unsuccessful in the practical field and the present Government torpedo is the device which had, prior to the contract at bar, been placed in the hands of the defendant by plaintiff's commercial competitor, the E. W. Bliss Company. An attempt is now made to stretch the contract in suit to make it cover not the Davison "Steam Generator for Automobile Torpedoes" referred to therein by the name with which plaintiff had christened it, but anything alleged to be within the terms of the patent in suit, which at the time of the contract did not exist as such; and, not only that, but also, disregarding the relative position of the patent in suit in the art, to cover the said Bliss torpedo which had previously been made and tested. The very terms of the license contract, which name and define the physical thing which the parties had in mind and to which the scope of the contract was limited, are now urged in an attempt to extend the breadth thereof. An attempt is made to show the United States and the Navy Department in an inequitable position, as acquiring benefit from the plaintiff for which they seek to avoid making compensation, and thus to estop the defendant from showing the true position of its present torpedo and of plaintiff's improvements with respect to the general development of the torpedo art.

As a matter of fact, the Government has obtained nothing from the plaintiff or its assignor. Its present torpedo is an embodiment of the teachings of the prior art, admittedly existing before the invention of the Davison "Steam Generator" in question, and, in the form of a practical, complete torpedo actually running in the water more than twice as far as any previous torpedo, was in the hands of the Government not only before the contract in suit was executed, but before negotiations leading up to the contract were begun.

The case is an exact introversion of the Harvey Steel case which originated in the same court below and was affirmed by this court. (196 U. S. 310; 38 Court of Claims, 662; 39 Court of Claims, 297.) In the Harvey case the United States undertook to pay for the use of the "Harvey process," which in the contract was identified in part by reference to a patent and, having avowedly used this identical "Harvey process," undertook to escape its obligations by claiming that the patent was in fact invalid or not infringed. In the present case the United States undertook to pay for the Davison "Steam Generator" when used, that device being identified in part by reference to the patent application which finally resulted in the patent in suit. The defendant has not used the Davison "Steam Generator" at all; and it is the plaintiff who is here seeking an unfair advantage by attempting to recover, not for the use of the Davison "Steam Generator," which the Government

has never in fact used, but for something different which it alleges is within the terms of the subsequently granted patent; and although what the Government has used was something with the production of which the plaintiff had nothing to do, and which was known to the Government and had been successfully tested at the testing grounds under the Government's supervision before the defendant ever heard of the Davison "Steam Generator."

THE DEFENDANT'S CONTENTIONS.

The defendant's contentions will be briefly as follows:

1. Since the court below on the basis of all the evidence has found *as a fact* that the defendant has not used plaintiff's device or invention (Finding XV, Record, p. 23), its conclusion that the plaintiff cannot recover presents no question of law the determination of which can lead to reversal.

2. The contract was for a definite physical thing—the Davison "Steam Generator for Automobile Torpedoes"—identified by and known to the Government only through a drawing or blue print. This device the Government has not used, but instead it has used a device radically different in construction and operation, which device was made by the Bliss Company for the Government before the contract in question was made or was even suggested. (*Harvey Steel Co.* v. *United States*, 196 U. S. 310; 38 Court of Claims, 662; 39 Court of Claims, 297.) This contention is discussed particularly in the second section of the brief.

3. The contract, in referring to a device covered by a patent application then pending in the Patent Office and not fixed in the form of a patent, and more especially since the content and tenor of the application was not considered by the parties, can be held at the most only to relate to what the parties could reasonably have expected to be patented; that is, to the actual novelty in the disclosure of that patent application, irrespective of the form of the claims which the Patent Office subsequently permitted in the patent document. (*Eclipse Bicycle Co.* v. *Farrow*, 199 U. S. 581.) This is discussed particularly in the second section of the brief, pages 83–89. In the present instance the Government utilizes devices not novel with plaintiff's assignor, Davison, but actual embodiments of inventions of the prior art which existed not only in the form of printed publications before the date of his invention (see third section of the brief, pages 104–117), but which actually existed in the form of a completed torpedo built by the Bliss Company and successfully tested under Government supervision long before the contract was signed and even before negotiations leading to the contract were begun.

4. The patent in suit can not include and cover what was known to the public through a printed publication before the date of the patentee's invention and which the Government uses; and in fact it does not in its terms cover this. This is discussed in the third section of the brief.

FIRST SECTION OF THE BRIEF.

No arguable question of law can arise in view of the finding of fact that the defendant does not use.

1. There is no point of law in this case the determination of which could lead to the reversal of the judgment below.

The prayer of the petition (Trans. Rec. p. 4, bottom of page) is for judgment as royalty in accordance with an agreement designated a "Shop License" (appearing on pp. 5–7 of the record) *and* as compensation under the Act of Congress of June 25, 1910.[1] The prayer for relief under license is inconsistent with that for relief under the Act of 1910 referred to which provides for relief when the Government has used an invention "without *license* of the owner thereof or lawful right to use the same." The whole case, however, has been proceeded with as founded on contract, and it is this aspect of the case which will be first considered under this heading.

The court has found as a fact that—

> It does not appear from the evidence that any of said devices or inventions have been manufactured or used by the United States. (Rec. near top of p. 23.)

The finding of law is (immediately below, on same page)—

> that the plaintiff is not entitled to recover, and its petition is therefore dismissed.

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[1] **Act of June 25, 1910, c. 423; 36 Stat. 851: Comp. Stat. Sec. 9465.**

The opinion (same page) concludes:

> * * * the court is of the opinion that the shop license should not be so liberally construed as to prevent the Government showing the exact nature of the device it used and its difference from that covered by the plaintiff's claims.

Certainly there can be no fault found with this statement of the law. The shop license provided only for payment on torpedoes equipped with plaintiff's "Steam Generator for Automobile Torpedoes." Whether the license be liberally or otherwise construed, the defendant certainly does not have to pay for what it does not use under a contract which, leaving defendant the option whether to use the device or not, provides only for payment based on use. And the Court below has positively found as a fact that the defendant does not use.

This finding was made after consideration of all the evidence adduced in a lengthy trial. The petition was filed in 1914 and the record was not completed so that the case was ready for argument until 1918 and thereafter a new trial was granted and still further and important evidence taken (opinion of the court, Rec. p. 23). No less than six motions for amendment of the findings of fact were presented (Rec. pp. 7, 8 and 32), and four of these were granted, at least in part. The evidence related to highly technical subject matter involving the theory of operation of torpedo power plants and abstruse questions of physics and thermodynamics. As indicated in part

by some of the findings of fact, the Court among other things considered the history of torpedoes (Finding IV, p. 9), reports of technical investigations (Finding V, p. 10), and no fewer than fifteen prior patents and publications (Finding XIV, p. 23). None of the expert evidence explaining this subject matter is carried forward into the present record.

Appellant in its brief has apparently ignored the fact that this is a case at law. It proceeds as in an appeal in equity and its argument abounds in statements having no foundation in the record. Many of these relate to technical subject matter, such as should be explained by experts. There is extensive discussion of technicalities of torpedo construction, a lengthy exposition of the patented structure containing much theory not found in the patent itself and an argument concerning the prior art, all containing many statements the correctness of which we dispute. To meet this, we have necessarily embodied in the third section of our brief an explanation of the prior art, handicapped, however, by our unwillingness to go outside the record for its exposition. This condition clearly demonstrates that the question of infringement was one for determination by the Court below as a fact in the light of all the evidence.

Where, in the light of exhaustive evidence on subjects of this character, the Court has made a positive finding that defendant does not use plaintiff's device, it is difficult to see how its finding can be set aside. This Court could only reach its own inde-

pendent conclusion as to whether the finding was erroneous by going over the whole evidence which was before the Court below. Surely this Court will not on such a highly technical subject without the aid of the expert and other evidence which aided the lower Court, reverse that Court in its comparison and evaluation of the structures involved. (See *U. S.* v. *Sociëté Anonyme,* 224 U. S. 309 at 322, referred to below.)

The Court will not reexamine the findings of fact made by the Court of Claims on evidence.

Keokuk & Hamilton Bridge Co. v. *U. S.*, 260 U. S. 125.

Union Pacific Ry. Co. v. *U. S.*, 116 U. S. 154, 157.

Talbert v. *U. S.*, 155 U. S. 45.

In the *Union Pacific case*, this Court said (p. 158):

> A conclusion could only be reached by considering all the testimony, weighing the facts, and weighing their comparative value as evidence. This presented in no just sense a question of law.

The finding made by the Court below is in a case of this nature a finding of fact not subject to review on the present appeal. Walker on Patents, fifth edition, says (Sec. 500, pp. 566 and 567):

> Generally speaking, all questions of similarities or of differences between things, are questions for the jury in an action at law, and are therefore proper to be testified about by experts. Where a patent covers such of the things described, as perform a particular func-

tion, it is the business of the jury to decide, and therefore proper for an expert to testify, which those things are. And in general all issues of fact, including the issues of abandonment, invention, and infringement, are for the jury to decide, and their findings on these issues will not be disturbed unless against the weight of evidence.

> An exception to this rule is where the defendants' device is made under a patent and the court is able from mere comparison to comprehend what are the inventions described in each patent involved in the action. In such case the question of infringement is solely one of law for the court to determine.

And, again, in considering trials of patent cases at law by a judge sitting without a jury, Walker states (Sec. 540, p. 598):

> Where the judge finds as a fact that the patent is void for want of novelty, or that the defendant has not infringed it, and thereupon enters a judgment for the latter, it is undeniable that the fact so found is sufficient to support that judgment. In arriving at his opinion the judge may have misunderstood or misapplied the tests of novelty, or of infringement, but still his finding is conclusive; because on an appeal from a judgment at law the Circuit Court of Appeals is authorized to examine nothing but the sufficiency of the facts found.

In a case like the present where the structures to be compared differ widely and where a thorough understanding involves expert technical knowledge and a consideration of a voluminous prior art, the

question whether the defendant's device is equivalent to the plaintiff's device or within the terms of the patented claims is proper subject matter for determination as a question of fact by the jury or by the court acting as a jury. A recent and specific illustration is found in the case of *Trustees* v. *Fountain Corporation*, 218 Fed. 642, wherein the Circuit Court of Appeals for the Second Circuit (Lacombe, Coxe, and Rogers) affirmed and approved the holding of Judge Ray in the Court below, reported in 210 Fed. 169, who in denying a motion to set aside a verdict for the plaintiff stated (pp. 171–172):

> Here the jury found that the one form of securing the sleeve to the box was the equivalent of the screw thread shown and an allowable equivalent in view of the prior art and the file wrapper and contents and the language of the claim, all of which was read and rehearsed to the jury. Can the court substitute its will and finding of fact for the finding of the jury, when that finding depends on the language and meaning and construction of a number of patents and the varying evidence of experts?

That this is the correct view of the situation is amply clear from the judgments of this Court in *St. Paul Plow Works* v. *Starling*, 140 U. S. 184; *Keyes* v. *Grant*, 118 U. S. 25.

In the former case this Court said at page 196:

> We can not review the finding of the Circuit Court that none of the earlier patents put in evidence by the defendant antici-

pated the plaintiff's invention. Although the defendant excepted to this finding as a conclusion of law, yet it was really a conclusion of fact on the evidence which the Circuit Court had before it. Witnesses were summoned on both sides as to what the earlier patent showed; and we can not consider the evidence, as if this were a suit in equity.

The following is an abbreviation of the opinion in *Keyes* v. *Grant* cited:

The judgment entered on the verdict rendered in favor of defendants, in pursuance of the direction of the court, can be maintained only on the ground, either that the legal identity of the furnace described by Karsten with that covered by the plaintiff's patent was manifest as a matter of law, or that it was established as a matter of fact so conclusively by the the evidence that a verdict the other way could not be supported within the rule as stated in *Randall* v. *Baltimore & Ohio Railroad Co.*, 109 U. S. 476.

Clearly it was not a matter of law that the specification of the plaintiff's patent, and the publication of Karsten, taken in connection with the drawings intended in illustration, described the same thing. The differences were obvious. * * * So that it certainly was not a matter of mere judicial knowledge, that these differences were either not material in any degree to the result, or, if material at all, were only such as would not require the exercise of the faculty of invention, but would be suggested by the skill of an experienced

workman employed to produce the best result in the application of the well-known arrangements of the furnace. It was claimed, on behalf of the plaintiffs, that the furnace described in the patent and as used by them, embodied an idea not contained in or suggested by Karsten's publication. * * * It was insisted by the patentees that no such arrangement and combination were to be found in Karsten's publication or in the furnaces depicted in his figures, and that the improvement which they constituted was not the result of mere mechanical skill, but sprang from a genuine effort of invention. And this view was supported by the opinion of many experts skilled in the art.

In our opinion this was a question of fact properly to be left for determination to the jury, under suitable instructions from the court upon the rules of law, which should guide them to their verdict. And there was evidence upon both sides of the issue sufficient to require that it should be weighed and considered by the jury in the determination of the question and this implies that, if it had been submitted to the jury and the verdict had been for the plaintiffs, it would not have been the duty of the court to have it set aside as not supported by sufficient evidence. The court erred, we think, in withdrawing the case from the jury as it did by directing a verdict for the defendants.

In the case of *United States* v. *Société Anonyme Cail*, 224 U. S. 309, the findings of fact of the Court of Claims seem to have lacked the explicitness of the

finding of non-user in the case at bar, this court indeed (p. 311) complaining of the indefiniteness of the findings. This court stated (p. 322) that infringement was a question of fact, to aid in the solution of which expert evidence not found in the record before it was usually available, and expressed its doubt as to whether it should re-examine the question and consider the prior art and the scope of the patent without such aid.

In *Battin* v. *Taggert* (17 How. 74, at p. 84) this court said:

> There are other questions of fact which come within the province of a jury; such as the identity of the machines used by the defendant with that of the plaintiffs, or whether they have been constructed and act on the same principle.

In the light of the citation of this decision by Mr. Justice Brown in his dissenting opinion in *Market Street Ry. Co.* v. *Rowley*, 155 U. S. 621, at page 630, the guarded language of the court in its prevailing opinion in that case, which is cited and followed in *Singer Co.* v. *Cramer*, 192 U. S. 265, 275, is significant. In the Rowley case the court took care to point out that:

> No extrinsic evidence *was given or needed* to explain the terms of art or to apply the descriptions to the subject matter, so that the court was able, *from mere comparison*, to say what was the invention described in each, and to affirm from such mere comparison whether the inventions were or were not the same.

> The question was, then, one of pure construction *and not of evidence*, and consequently was a matter of law for the court without any auxiliary fact to be passed upon by the jury. (Italics ours.)

This Court has in no case disapproved of the doctrine expressed in *Battin* v. *Taggert*, and it is evident that in *Singer Co.* v. *Cramer* above cited it intended to express merely an exception to the general rule when it said (see p. 275):

> It is apparent from the face of the instrument that extrinsic evidence is *not needed* to explain terms of art therein, or to apply the description to the subject matter, and as we are able from mere comparison to comprehend what are the inventions described in each patent and from such comparison to determine whether or not the Diehl device is an infringement upon that of Cramer, the question of infringement or noninfringement is one of law and susceptible of determination on this writ of error. (Italics ours.)

It is submitted that it is clear from this language that it is only in cases wherein the question of infringement or noninfringement is so readily ascertainable from a mere inspection of the documents and the devices, and would not be aided by expert or other evidence, that it is error for the Court to refuse an instruction to find a verdict, and that infringement becomes a question of law, and it is further clear that this modification of the general rule does not warrant the Court in taking the case from the

jury where the differences between the two devices are substantial and not merely colorable. (See same case, p. 286.) This is a view taken by Walker in his work as already quoted and is supported by the decision of the Circuit Court of Appeals in the Second Circuit (Lacombe, Coxe, and Noyes) in *Heide* v. *Panoulias*, 188 Fed. 914, in an opinion discussing *Singer Co.* v. *Cramer* and other decisions of this Court, and concluding (p. 917):

> In the case at bar there was conflicting testimony as to both invention and infringement. The experts disputed as to how prior patents worked and as to whether they were practical. * * * We are satisfied that under the authorities cited the trial judge would have committed error, had he decided these questions of validity and infringement, instead of sending them to the jury.

Where the finding of the jury or of the Court below has been made in view of evidence necessary to a proper interpretation of the structures and their modes of operation, which evidence is not before this Court, there is no basis for a review of the finding below.

If this be the rule as to a verdict found by an ordinary jury in those involved questions of fact present in patent cases, there is certainly no less reason for the rule supporting a positive finding of fact of noninfringement, as in the present case, by unanimous decision of the five learned judges of the Court of Claims, supported by a *per curiam* opinion.

It is conceivable that if it were apparent on the face of the papers and on an examination of the structures that no difference existed between the devices of plaintiff and defendant so that the error of the finding of the lower Court amounted to an error of law—so manifestly wrong that if the case had been tried by a jury it would have been error for the Court to have refused to charge the jury to find for the plaintiff—then this Court might, it is submitted, reverse the lower Court. But the differences between the two devices are manifest, numerous, and important; they spring to the eye from a mere examination of the plaintiff's and defendant's structures, as for instance in the contrast diagram facing page 150 below; they are so marked that the lower Court has found as a fact that the defendant has not used the plaintiff's device or invention; so important that plaintiff's device was a failure and defendant's a complete success. (Finding VIII, pp. 13, 14, and Finding XI, pp. 20, 21 Rec.) This finding founded upon, and the result of the weighing of, exhaustive evidence, including the evidence of those skilled in the art on both sides, this Court is asked to set aside, with only such information as is obtainable from its own unassisted comparison of the two devices.

If it be objected that this contention limits the right of appellant—it is sufficient answer that, as shown in *Union Pacific Ry. Co.* v. *U. S.*, 116 U. S. 154 at 157; *Tucker* v. *Spalding*, 13 Wall. 453 at 455, this limitation always exists in appeal or error in cases brought

at law, and the finding of fact is none the less binding on this Court, whose jurisdiction in such cases is limited to the review of points of law.

2. Still more clear is it that there is no error in law which could lead to reversal if the case be considered in the aspect of a prayer for relief under the Act of 1910, which is practically a trial of infringement.

The Act of 1910 puts all defenses in the hands of the Government and the burden of proving infringement is on the plaintiff. (*Agawam Co.* v. *Jordan*, 7 Wall. 583 at 609.)

From the discussion already given and the cases cited it is clear that in a case like the present, infringement is a question of fact. The rule is that if the differences between the patented device and the device complained of are obvious, it is not a matter of mere judicial knowledge to determine their materiality, especially where the differences are maintained by experts skilled in the art. Where there was evidence upon both sides of the issue sufficient to require that it should be weighed and considered by the jury, the jury's determination is final.

In the present case the lower Court has committed no error of law and has found nonuser or noninfringement, and the case presents no error open to revision by an appellate tribunal. The Court, finding the facts with the full force of a jury verdict, has, weighing the evidence, comparing the devices in the light of it, and not being led into any error by the wrongful admission of evidence or wrong charging or stating

of the law, is in position to render its finding with advantages that the appellate Court cannot possess.

On this point it is important to bear in mind that if the case be treated as one for infringement, the lower Court has pointed out the existence of devices in the prior art, experimented upon by the Government and others, and patented to Sodeau and others, which must be considered in interpreting the plaintiff's claims. In view of these the Court in its opinion said:

> The question resolves itself into whether the Government used the plaintiff's device or something covered by one of the claims of its patents. We are of the opinion it did not.

It is obvious that this Court is in no position to question this finding without reviewing all the evidence upon which it is founded, which is not before this Court, and which this Court has repeatedly refused to have brought before it on writ of error or appeal in cases at law.

SECOND SECTION OF BRIEF.

The Events Leading to the Contract, the Form of the Contract, and Its Significance.

In considering the contract at bar we will in this section of the brief first explain the circumstances in which the parties found themselves at the time of the contract and the events which led up to that contract. The surrounding circumstances are not only admissible but necessary for a true understanding of what the bargain was.

Nash v. *Towne*, 5 Wall. 689, 699.

Burdell v. *Denig*, 92 U. S. 716 at 721.

Merriam v. *U. S.*, 107 U. S. 437 at 441 and cases cited.

Chicago, etc., R. R. v. *Denver, etc., R. R.*, 143 U. S. 596 at 609.

See also Williston on Contracts, Section 629.

In *Nash* v. *Towne*, cited, the Court said (italics ours):

> Courts, in the construction of contracts, look to the language employed, the subject matter, and *the surrounding circumstances.* They are never shut out from the same light which the parties enjoyed when the contract was executed, and, in that view, they are entitled to place themselves in the same situation as the parties who made the contract, so as to view the circumstances as they viewed them and so to judge of the meaning of the words and of the correct application of the language to the things described.

The history of the adoption and use of water-cooled superheaters by the Government.

In 1907 Lieutenant Neves of the Brazilian Navy was at Fiume (at that time in Austro-Hungary) at the Whitehead Torpedo Works there. A novelty that came to his attention was a torpedo designed by Lieutenant Gesztesy of the Austrian Navy which was then being made ready for tests. He procured a description and illustration of this torpedo and sent it back to Brazil and in January, 1908 (Finding XIV, 14, p. 22), this was published in the *Revista Maritima Brazileira* (The *Brazilian Maritime Review*). This

article, which describes the torpedo later described in the British and French patents constituting Exhibits C 12 and C 13, respectively, is Exhibit C 14 reproduced in the Addition to Record, pages 63 and 35, and a diagram of the Gesztesy torpedo as described therein appears on page 103 following.

The Court below in its findings of fact (Finding V, paragraph 1, p. 10) characterizes the Gesztesy power plant as one providing "for the generation and use of steam in combination with compressed air and the gases of combustion for motive power" and this is effected by adding to an outside superheater a water tank with provision for admitting some of the compressed air to this water tank to displace the water and feed it to the combustion chamber.

This article in the Brazilian technical journal promptly came to the attention of officers in the Bureau of Ordnance. (Finding V, 1st paragraph, p. 10.) Recognizing it as an attempt to take practically a further step in the improvement of torpedo power plants, it was forwarded by the Bureau on March 26, 1908, to the E. W. Bliss Company, a commercial firm then, as now, manufacturing torpedoes for the Navy. On April 4, 1908, the Bliss Company returned the article with the statement (italics ours) that it had *for some time* had plans on the same general principle as that shown and that while they believed there were inherent difficulties against the successful operation of such a system, it intended at as early a date as possible to make certain tests of it. (Finding V, 2nd paragraph, p. 10.)

The Bureau of Ordnance urged the Bliss Company to continue its experiments on this line, to which the Bliss Company replied that at that time their testing facilities were fully engaged with current work. (Finding V, 3rd paragraph, p. 10.) At this time the final work in improving the outside superheater was under way, the Navy then being equipped with torpedoes of the inside superheater type, but by 1909 the outside superheater was perfected and in use by the Navy. (Finding IV, 2nd paragraph, p. 9.) By 1910 the Bureau of Ordnance received verbal information from the Bliss Company as to their experiments with water injection and the later action of that company as described herein clearly shows that they were fully abreast of the art and prepared with practical as well as theoretical knowledge of the subject.

Meanwhile, after the United States had in 1909 obtained outside superheater torpedoes, it did not neglect efforts toward still further improvement and undertook on its own account experiments relating to the injection of water. These experiments began in November, 1909, at the Naval Torpedo Station at Newport (Finding V, 4th paragraph, p. 10), and the clear understanding of the principles involved is shown by the official report covering these experiments made by the Ordnance engineer in charge in June, 1910, referred to and quoted in part in Finding V, p. 10. In that report the Ordnance engineer pointed out that in view of the limit of permissible heat on account of the melting or burning of material,

or the weakening of the structure of the mechanism, the only recourse for increasing the run of the torpedo (the air charge being fixed) was by adding to the volume of the air; that the problem therefore resolved itself "into that of injecting or otherwise introducing some liquid (water obviously being most suitable) into the heater space, the liquid by its evaporation absorbing the excessive heat and adding its own volume to the volume of the air," more fuel being burned "to give a higher temperature to evaporate more water to add more volume," and that the final limit to the possible gain in that direction was fixed by the amount of oxygen in the air flask charge which could be consumed in supporting combustion. In the letter transmitting the report the following statement was made (italics ours):

> As will be seen from the description, the basic principle of the new design is the attempt to increase the range of the torpedo by the *introduction of some liquid, preferably water, into the superheater pot, the excess heat* of the combustion of the alcohol or kerosene used as fuel *being utilized to vaporize the liquid and increase the volume.* (Finding V, p. 11.)

At the time of this report the work on water injection was laid aside, not abandoned for failure as appellant contends, while those details were perfected "which have nothing to do with the heater" (Record, p. 11), and the record shows (p. 15) that the entire work was nearing completion when it was superseded by the successful development of the present Bliss torpedo.

The plaintiff company also had approached the problem through its employee Davison, formerly a naval officer in charge of torpedo development. Davison filed his application for the patent in suit on March 29, 1909 (Finding II, p. 8), although it did not issue until August 20, 1912, long after the events about to be discussed. The Government first learned of his work on July 26, 1910 when Commander Norton, the Bureau of Ordnance officer in charge of torpedo work, visited the plant of the plaintiff company for conferences on the subject of air compressors and gyroscopic control gear. At this time he learned something from Davison of his experimental work on the problem but was shown no component parts of the apparatus used. The work had evidently been abandoned, as Commander Norton requested Davison to *take up again* the development of his device. (Finding VI, p. 11.) It should be borne in mind that this visit of Commander Norton, when he first learned of any of Mr. Davison's work was subsequent to the Government's own work above referred to and after the official report to the Bureau of Ordnance based thereon made in June, 1910. (Finding V.) Thus Commander Norton and the Bureau of Ordnance were already familiar not only with the theory of the subject but with the practical problems involved.

The two needs of the Navy: First, to develop a long-range torpedo; afterwards, to modernize old torpedoes.

By 1910 the question of developing a long-range torpedo was an active one. It was generally understood by those familiar with the subject that such development would follow the lines of water injection. The E. W. Bliss Company, the plaintiff company, and the Navy on its own account all were canvassing the possibilities, and we may imagine that other navies were not idle. The situation was of vital interest to the United States. Our Navy could not be behindhand. The Gesztesy torpedo had already been tested at the Whitehead works at Fiume and naval officers of other countries, like Lieutenant Neves of the Brazilian navy, had seen it. Gesztesy's French and British patents had been published. The Sodeau British patent 6081 of 1907 of the British munition firm of Armstrong-Whitworth Company had been published. (Finding XIV, p. 22.) It was essential to the efficiency of our navy that the long-range torpedo should be completed in engineering design, should be reduced to practice as an actually existent thing in metal, a torpedo to run in the water, a weapon as efficient as any an enemy might have.

From this situation arose successively two demands of the United States Navy, and these led, respectively, to two entirely separate negotiations with the plaintiff company, from the second of which came the contract at bar.

The first need of the Navy was to develop a long-range torpedo, to demonstrate that it was a possible and practicable thing, to design a practicable power plant, to coordinate it with the other mechanisms of the torpedo, to build in fact a reliable functioning weapon. To meet this need it set to work, as we shall show, all available agencies and put in competition with its own engineers the E. W. Bliss Company and the plaintiff Company. In this competition the plaintiff Company failed completely. The Bliss Company built the Government's present torpedo and by September, 1911, it was running over 9,500 yards on the Government testing range.

The second need of the Navy arose only when the first had been satisfied, after the Bliss Company had demonstrated that the long-range torpedo was a possible and practicable thing. The plaintiff was still working on its own design of new torpedo and now raised an entirely new question. It stated that it had developed something new, a device which could be installed in old torpedoes and which would double their range. The Navy recognized the importance of such a device. It promised to meet the situation which had arisen from the success of the Bliss torpedo. At the end of September, 1911, the Navy had on hand a large number of Whitehead torpedoes of 4,000 yards range and under (Finding IX, top of p. 15), and it had the single new Bliss torpedo which had already run over 9,500 yards on the testing range, considerably more than twice the range of these old Whiteheads

(Finding IX, last par., p. 16) and which made them practically obsolete. It is a matter of common knowledge that at that time there was grave fear of war with Japan. If the Navy went out to fight, it would not be equipped with the best possible weapons, as it was impossible to construct overnight large numbers of the new torpedoes just perfected. The first problem, that of demonstration, had been solved; a second had arisen, one of equipment.

From the negotiations with respect to this new proposition of the plaintiff, characterized by the Bureau of Ordnance in one of its indorsements on the plaintiff's offer as "an entirely different proposition" from the first one relating to the development of a new torpedo (Finding IX, p. 16, top), under which the plaintiff was still working, arose the contract at bar. It concerned the second need of the Navy, which plaintiff proposed to meet, the need of rapid equipment.

The first problem: Plaintiff's unaccepted offer of August 8, 1910. Competitive work in developing long-range torpedo instituted.

After Commander Norton had learned on July 20, 1916, of Mr. Davison's interest in and experiments with torpedo power plants, the plaintiff's first dealings with the Government related to the first need of the Navy, the need for developing and demonstrating the long range torpedo.

Shortly after Commander Norton's visit to the plaintiff's plant, that company made a proposition to the Bureau of Ordnance which is embodied in

Finding VII on page 12 of the Record. This proposition is interesting chiefly for its audacity. This company, which did not get any torpedo into the water until more than two years later, wished to unload its untried devices on the Government, to do the manufacturing on a cost plus basis with the addition of exorbitant royalties, and also asked for a cash payment of $100,000 down. This offer was never accepted or considered by the Government and its terms are of interest only in so far as they contrast with those of the contract at bar and demonstrate that the latter is a contract for a limited purpose only.

The proposition was absurd. The plaintiff had nothing to show. It did not even offer to show anything. "All plans and detailed information" were to be furnished only "when the license agreement goes into effect." (Record, p. 13, second paragraph.) The Government was offered a pig in a poke. It already had its own experiments well in hand; it had been receiving verbal reports as to the experiments of the E. W. Bliss Company. The proposition of this letter was never considered and it drops out of this case. Indeed, appellant nowhere refers to it in its brief, but it is mentioned here because it appears in the findings of fact.

Instead the Bureau of Ordnance proceeded with a plan for "determining the merits of the different motive power systems for increasing the range and speed of torpedoes" and on September 6, 1910, addressed both to the Electric Boat Company and to the Bliss Company substantially similar letters, proposing to each company that it undertake on an

experimental basis the production of two long-range torpedoes of different sizes, a certain performance to be the minimum and a bonus to be paid for a higher performance. In due course similar contracts were entered into with both companies, those with the plaintiff company being dated January 17 and 23, 1911, and those with the Bliss Company being dated February 16, 1911. (Finding VIII, first paragraph, p. 13.)

It is of interest to point out here that the plaintiff was fully aware of the conditions existing at the time and the presence of competitors in the field, as the Bureau informed each company that the torpedo constructed by it would be placed in competition with a torpedo to be submitted by another firm and with torpedoes being developed by the Bureau itself. (Finding VIII, first paragraph, p. 13.)

Unsuccessful work by plaintiff company in the competition.

The Electric Boat Company promptly undertook to build two experimental torpedoes. The history of its work on these torpedoes is simple. The proposition for its construction was broached in the fall of 1910. The formal contracts were signed on January 17 and 23, 1911. Not until October, 1912, did the Electric Boat Company complete one of the torpedoes. This torpedo did not develop the minimum range and speed required, although this minimum was only 4,000 yards, in itself no increase over what old torpedoes could do (Finding IV, second paragraph, p. 9), and the other experimental torpedo,

the 21-inch, was never completed. (Finding VIII, last paragraph, p. 14.) Since (as we shall show) the E. W. Bliss Company had in the meantime developed the present Government torpedo and it had been officially adopted and was being ordered in large numbers by the United States, the plaintiff company did not wish to spend any more of its time and effort on its unsuccessful work, and, at its own request, the contracts for experimental torpedoes were cancelled "without penalty" on June 16, 1914. (Finding VIII, last paragraph, p. 14.)

Prompt success of E. W. Bliss Company with defendant's present torpedo of Sodeau type.

The story of the development of the present Government torpedo with water-cooled superheater by the E. W. Bliss Company under the contracts of February 16, 1911, for building two experimental long-range torpedoes is much shorter in point of time but considerably more eventful in matter of results. We have already seen that the Bliss Company had, as early as April 4, 1908, told the Navy Department that it had "plans" which involved the use of water in torpedoes. (Finding V, 2nd paragraph, p.. 10.) In response to the invitation of the Navy Department, on September 6, 1910, to undertake experimental torpedoes, the E. W. Bliss Company in the course of correspondence about a month later in its letter of October 14, 1910, made the following statement (Finding V, last two paragraphs, p. 11) (italics ours):

> As the Bureau is probably aware, we have designed a new 21-inch torpedo on the general

> lines of the Mark VI with a device added which enables us to *inject water into the superheater and materially increase the efficiency.*
>
> While we have not yet carried our experiments in this direction to a finish, we have already obtained *twenty* million pounds of work out of the Mark III twenty-one inch flask full of air against *ten to eleven* million which we developed with the standard Mark III torpedo.

The E. W. Bliss Company worked first on the larger of the two experimental torpedoes—the 21-inch by 21-foot torpedo. It was completed in August, 1911. (Finding VIII, 2nd paragraph, p. 14.)

As early as September 24, 1911, the Government had this torpedo on the testing range at Sag Harbor and it had made a run of over 9,500 yards (Finding IX, last paragraph, p. 16), nearly five and a half miles.

We may be pardoned for digressing here to state that all this happened before the Department received plaintiff's letter of October 20, 1911, which contained its initial proposal leading up to the contract at bar.

The Bliss 21-inch torpedo was officially tested in the fall of 1911, accepted and paid for by the Government on the basis of having attained a range of 10,000 yards at a speed of 26 knots (Finding VIII, 2nd paragraph, p. 14), two and one-half times the range provided for by the contract (Finding VIII, 1st paragraph, p. 13) and two and one-half times the range of the outside superheater torpedoes which

the Navy had (Finding IV, 2nd paragraph, p. 9). The 18-inch torpedo was completed later, in May, 1912, and its performance in the test was far in excess of the minimum requirements of the contract and it was accepted and paid for. (Finding VIII, 2nd paragraph, p. 14.)

The success of the Bliss torpedo was immediate. The 21-inch torpedo, which had demonstrated its powers as early as September, was at once accepted. By January 18, 1912, the Bureau of Ordnance was preparing a contract with the Bliss Company for the manufacture of 50 torpedoes having similar power plants, and in the month of June, 1912, as appropriations became available, the Government let contracts to the Bliss Company for the manufacture of 290 torpedoes of this type. (Finding VIII, 3rd paragraph, p. 14.) From that time on the power plants of torpedoes used by the Navy and now complained of in this suit, except for slight improvements and modifications, have been "practical duplicates" of that of the Bliss Company torpedo which was tested and accepted by the Government in the fall of 1911 (Finding XIII, last paragraph, p. 22), and which as early as September, 1911, was running between nine and ten thousand yards in free route in the water on the Government's testing range. (Finding IX, last paragraph, p. 16.)

THE OCCASION OF THE CONTRACT—PLAINTIFF BROACHES THE SECOND PROBLEM, THE CONVERSION OF OLD WHITEHEAD TORPEDOES.

The first problem of the Navy, the production of a long-range torpedo had been solved by September 24, 1911. The plaintiff had as yet done nothing. It was not till a year later that it even completed a torpedo. (Finding VIII, last par. p. 14 and Finding XI, first par. p. 21.) But the Bliss torpedo was on the Government testing range at Sag Harbor and had run over 9,500 yards. (Finding IX, last par. p. 16.) Then arose the second problem, the problem of the old short-range torpedoes on hand which had suddenly become obsolete. Could these be expeditiously and cheaply brought up to date?

It was in connection with this second problem, arising only after the Bliss Company had solved the first, that the negotiations leading to the contract in suit began, negotiations entirely separate from and independent of any previous dealings with the Electric Boat Company. On October 20, 1911, came the new proposition. We quote the following paragraphs from plaintiff's letter of that date reproduced in Finding IX, page 14 (italics ours):

> 1. We beg to inform the bureau that we *have developed a device* which may be applied to *any automobile torpedo now in service,* and which will more than double the range of such torpedo.
>
> 2. We enclose herewith drawing No. C–10277 showing a general arrangement of this device applied to the Whitehead 5.2 m. x 45 cm. torpedo.
>
> *   *   *   *   *

6. If the bureau desires us to fit one of its existing torpedoes with *this device*, we shall undertake to do so after arranging with the bureau for a *royalty to be paid on all torpedoes fitted with this device* in the future.

7. Our estimate of time required to *modify an existing torpedo* is five months, and cost fifteen hundred dollars ($1,500).

8. We would ask one thousand dollars ($1,000) royalty per torpedo for the first ten torpedoes, nine hundred dollars ($900) per torpedo for the second ten, and eight hundred dollars ($800) per torpedo for all torpedoes thereafter.

Accompanying this letter as the only explanation of "the device" referred to was a drawing or blueprint. The form and character of the said device are shown by the drawing and description constituting Exhibit 1 of the appendix to the findings of fact, the drawing facing page 24 of the Record. (Finding XI, first and last paragraphs, p. 20.)

The language of the letter wherein the plaintiff "informs the Bureau" that it has developed a new device for a specific purpose clearly shows that it relates to a new subject matter. There was no need of informing the Bureau that it had a design for a long-range power plant. The Bureau had heard of that more than a year before and the plaintiff was working on that device under a contract.

What were the parties now talking about? Evidently "*this device*" was the thing shown in the drawing, which was capable of being *applied to the Whitehead*

torpedo. The proposition was, as stated in paragraph 6 of the letter, for a royalty to be paid by the United States "on all torpedoes fitted with *this device* in the future," that is, with *this device;* the thing shown in the prints; the installation for the *conversion of Whitehead torpedoes.*

This letter was forwarded to the naval torpedo station for comment, and the following report was made by Commander Williams (Finding IX, p. 15):

> 1. The blue print forwarded herewith gives no information as to the methods by which the range of the torpedo is to be doubled beyond stating that the device is a steam generator. It is presumable that the device consists of a superheater into which is injected water. *The E. W. Bliss Company, proceeding along the same lines, have already a torpedo in the water which indicates the possibility of doubling the range of the torpedoes now in the service.* The torpedo station will in a very short time take up actual tank experiments with a new form of superheater which promises to double the range of the torpedo. The Schneider Company and the Whitehead Company are both experimenting with a superheater into which water is injected.
>
> 2. In view of the above it is not considered wise to enter into an agreement with the Electric Boat Company by which the bureau agrees to pay the Electric Boat Company a royalty for the use of a device in torpedoes presumably similar to devices made by other companies and to one which is in the course of development at the torpedo station, as by that

> action the bureau would, in the opinion of the torpedo station, possibly involve itself in dispute if not in litigation with the other companies, and would be estopped from further development of its own superheater.

In other words, Commander Williams feared that the contract might cover the Bliss torpedo then in the Government's hands and the torpedoes with which the Government had been experimenting and torpedoes which foreign companies had developed—all along the lines of water-cooled superheaters. Commander Norton, at the Bureau of Ordnance, answered on November 2, 1911 (Finding IX, bottom of p. 15):

> 2. The proposition submitted by the Electric Boat Company in the attached letter as understood by the bureau is in effect as follows:
>
> That they will take one of the present type of torpedoes, a Mark V Whitehead, or a Mark III, IV, or VI Bliss-Leavitt torpedo, and by the installation of the Davison steam generator and the removal of superheater, practically double the range of the torpedo, provided the torpedo will stand a lengthening of eight inches.
>
> 3. As the inspector of ordnance is no doubt aware, the bureau has contracts with the Electric Boat Company to furnish 2, 5.2 m. x 45 cm. and a 21′ x 21″ torpedo of the Davison type, which torpedoes will be run some time this fall or early next spring.
>
> 4. The attached correspondence is in reference to an *entirely different proposition* and yet connected with that proposition, inasmuch as

> the steam generating device will be incorporated in the Davison torpedoes, and the bureau is *given to understand that this generator is not in any sense a superheater*, that it has been patented, and *it is not to conflict with the present superheater rights*.
>
> 5. Comment is desired on the advisability of loaning the Electric Boat Company a torpedo of the Mark IV or Mark VI types, in order that their device may be installed therein for test, since if it is possible to increase the range of the present four thousand yard torpedoes to eight thousand yards, a long-range torpedo could be obtained without much change in the installation for launching them overboard.

It is clear from the above what the Bureau of Ordnance understood the proposition to be. Certainly it had nothing to do with plaintiff's old letter of August 8, 1910, and appellant no longer contends that it had, not even mentioning that letter in its brief. That absurd proposition bore on the development as a new thing of a long-range torpedo. That was a dead issue. The success of the E. W. Bliss Company had killed it. This, as the Bureau of Ordnance said, was "an entirely different proposition." In a time of need the Electric Boat Company showed the Bureau of Ordnance a specific thing, a drawing of an installation with the proposition that the old Whitehead torpedoes could be changed over in five months and that the range could be doubled; that is, brought up from 4,000 to 8,000 yards. The proposition of a long-range torpedo was nothing novel. Commander Norton already

knew of the Bliss torpedo which was running 10,000 yards. That was a complete new torpedo and was not a device, such as the plaintiff now offered, which could be installed in old Whitehead torpedoes. If in a short time the Navy could bring its old torpedoes up to somewhat near this standard, it was a matter of decided interest, particularly in view of the political situation existing at that time.

On November 9, 1911, long after it was acquainted with the success of the Bliss torpedo, the Bureau replied to the letter of the Electric Boat Company. Its answer is reproduced in Finding X, p. 16. Paragraph 4 states that it is understood that the price of $1,500 each paid for the conversion of the first two torpedoes which the Electric Boat Company was to undertake would cover the royalty payment. Paragraph 5 sets as a minimum standard a 50 per cent increase of range; that is, to 6,000 yards, although the Electric Boat Company expressed its confidence of doubling the range to 8,000 yards. Paragraph 6 (p. 17) is quoted herewith (italics ours):

> If this arrangement be agreeable to the Electric Boat Company, please so inform the bureau in order that a requisition may be prepared for the converting of two 5.2 m. x 45 cm. Whitehead, Mark V, torpedoes at a total cost of three thousand dollars ($3,000), and that an agreement may be drawn up for signature by the Navy Department and the Electric Boat Company in regard to *the royalty to be paid for any torpedoes that may be converted hereafter*, namely, at the rate of $1,000 per torpedo for the first ten torpedoes

converted, $900 per torpedo for the second ten torpedoes converted, and $800 per torpedo for all torpedoes converted thereafter. (Finding X, p. 17.)

We may be pardoned for digressing here to point out that all this correspondence, including the original offer of October 20, 1911, was subsequent to September 24, 1911, when the Government had on the testing range at Sag Harbor the Bliss torpedo which had already made a run of over 9,500 yards. (Finding IX, last paragraph, p. 16.)

On December 6, 1911 (Finding X, p. 18), the Electric Boat Company wrote (italics ours):

> As regards paragraph 6 of the bureau's letter, it is our understanding that the royalty will apply not only to torpedoes which may hereafter be converted, but also to torpedoes which the Government may build at its own works, and *in which the device in question is to be used.*

On December 13, 1911, the bureau notified the company that it had made requisition for two Whitehead torpedoes and forwarded a blank shop license requesting the Electric Boat Company to fill in the proper blanks, the numbers of letters patent, and the like. (Finding X, p. 18.) The patent applications, including that on which the patent in suit was later granted, were never seen by the Bureau. (Finding X, last paragraph, p. 20.)

This blank shop license became the contract in suit which grew out of and was based on the offer of the plaintiff to increase the range of the old Whitehead torpedoes to 8,000 yards.

Tardy and unsuccessful result of the Whitehead undertaking.

The plaintiff company had contracted to take old Whitehead torpedoes and increase their range up to 6,000 yards by the addition of "the device in question." It had claimed that it could more than double the range, that is, increase the range to more than 8,000 yards, and had signified its ability to complete the work within five months. Requisition for these torpedoes was made in December, 1911. (Finding X, paragraph numbered 1, p. 18.) It was not until almost a year later, to wit, November, 1912, that these torpedoes were sent to the torpedo station at Newport for tests. (Finding XI.) After a long period of experiments at the torpedo station *one* of these torpedoes exceeded on *one* occasion the minimum run of 6,000 yards required for acceptance. On September 27, 1913, the naval torpedo board reported on these torpedoes as follows, Finding XI, p. 21 (italics ours):

> In reference to paragraph 1 (f) of the precept. The board is of the opinion that—notwithstanding the fact that one Whitehead torpedo fitted with the steam generating device did, on one occasion, make a run of 6,000 yards at 27 knots—after a long period of experiments at the torpedo station, the *reliability of this form of steam generator has not been established*, and, due to the use of salt water, *there are grave doubts as to the practicability of this device*, as at present fitted, for service use.

> It is recommended that no steps be taken toward the *conversion of service Whitehead torpedoes* into steam torpedoes of this modification until further investigation by the torpedo station has removed these doubts.

One Whitehead with the plaintiff's steam generating device, which it was hoped would give a range of 8,000 yards, on a single occasion nosed its way a few yards over the minimum of 6,000 yards specified in the contract. Here was a certain color of success. The Electric Boat Company had expended much money and effort on this work of such unsuccessful outcome. The money and effort had been spent in the best of faith and in an attempt to meet a real need of the Navy Department. The sum involved was small—$3,000. Therefore, on October 6, 1913, the department passed on the plaintiff's bill and recommended that payment be made under the contract. (Finding XI, pp. 20, 21.) The Electric Boat Company has never made any other torpedoes for the Government and, in accordance with the recommendation of the board just quoted, the Davison "Steam Generator" has never been used in any of the Government's torpedoes except these two old Whiteheads in which the plaintiff installed it.

WHAT THE UNITED STATES CONTRACTED FOR.

The Contract for a Specific Device Not Now Used.

> "The purpose of the license agreement was to secure to appellee the right to use the steam generator devised by Davison, regardless of any question either as to the validity

of patents he might obtain or as to the scope of their claims. Appellee was not concerned with any such matters, and that is why it did not think it necessary to examine the Davison application then pending in the Patent Office and in fact did not do so." Appellant's brief, p. 65.

This statement of appellant is what we have always contended. It sweeps away the labored arguments in appellant's brief as to the wording of the patent and the scope of its claims and leaves only the relatively easy question as to what the Davison "Steam Generator," so known to the parties at the time of the contract, was. An examination of the facts shows that it was the device of the drawing, the device to be used in converting old Whitehead torpedoes and nothing else.

What did the Electric Boat Company have to sell the United States and what could the United States have possibly wanted to buy from the Electric Boat Company except "the device in question," the device "known as Steam Generator for Automobile Torpedoes," the specific thing? A long-range torpedo, the Bliss torpedo, like those now complained of, was in the possession of the United States at the time. The Bureau of Ordnance knew all about its capabilities. The Electric Boat Company had never produced a torpedo.

The principle of water injection had been known to the Bureau at least as long before as the publication of the Gesztesy article in 1908, and had been made

the subject of experiments conducted by the Government itself at the torpedo station. By the plaintiff and by Mr. Davison the Bureau had been told of some past experiments which had had no practical fruition but had not even been shown any parts of the apparatus used. (Finding VI, p. 11.)

Although that was the situation, plaintiff's counsel now asks the court to believe that the officers of the Bureau of Ordnance assumed that Mr. Davison was a pioneer and inventor of the principles of water injection and that they negotiated on behalf of the United States a general patent license to cover and protect the United States with respect to the Bliss torpedoes which the Government already had in its hands. If the proposition were not so absurd, it would be insulting. We are asked to believe that intelligent men, Commander Norton and Admiral Twining, could, on no evidence at all, assume that an inventor who came to them with practically empty hands, who had never produced a torpedo, who had shown them nothing in metal, who brought them nothing but a half-comprehended sketch of an untried project, was a pioneer in an art with which they had long been familiar, and that he dominated and controlled a successful development originated and already carried to conclusion by another and competing company. This assumption would be based on the fact that they were told that the Electric Boat Company and Mr. Davison had what?—not patents, but patent applications with the contents of which they were unfamiliar and of which, when

they assented to the contract, they were not even informed as to the filing dates, and asked plaintiff to add them to the license. Plaintiff's reply spoke of them as "patents and applications whereby *this device* is protected." (Finding X, p. 18, and last paragraph, p. 20.) Had these officers had the slightest suspicion that they were entering into any agreement involving broadly the control of the water-cooled superheaters they would have insistently demanded a complete disclosure of the contents of the secret patent applications of the Electric Boat Company and sought technical advice. They did not do so because they were "given to understand" that they would not be embarrassed in any way as to the development of the Bliss type of water-cooled superheaters which they already had in their possession, and because they understood the contract to be for the use of a specific device devised by the Electric Boat Company for altering over old Whitehead torpedoes, and identified to the parties by a picture, a drawing, and not by the legal scope and disclosure of patents.

Remembering that the Government visualized "the device in question" from the drawing, could they conceive that the Bliss torpedo was any embodiment or colorable modification of that device? That torpedo (which the Government then had in the water and successfully tested), as hereinafter explained (infra, p. 112), takes the old outside superheater with a single liquid-containing tank (for fuel) and a single system of piping adapted to feed one liquid to the

combustion chamber by displacing or forcing it from the tank by a portion of the compressed air, and duplicates that chamber and system of piping so that two liquids (fuel and water) are fed instead of one, but in exactly the same way. What was "the device in question"? It is shown by the drawing forming part of Exhibit I and reproduced in the record facing page 24. (Finding XI, first and last paragraphs, p. 20.) There is no such duplication. Instead of a water tank there is provided a pump, marked "Fig. 5" in the drawing, with a sea intake not present in the Government's Bliss torpedo. There is a regulator chamber and overflow (fig. 6) connected to this pump. There is an equalizing valve which throttles down and controls the pump and an air connection thereto. Besides the main reducing valve there is an auxiliary reducing valve (fig. 2), not present in the Government's device, that works as a kind of relay. Instead of feeding the fuel directly by displacing it by air, a pipe is led to the fuel tank that pumps water into it and displaces the fuel by water forcing it into the combustion chamber. It has, or is claimed to have, all the devices of defendant's patent shown in the diagram on page 118 of this brief and a number of other devices, such as the auxiliary reducing valve. Apparent to any eye are fundamental ideas of design, the idea of not carrying water in the torpedo, as is done in the Government torpedo, but of pumping it in from the sea; the idea of feeding fuel, not by displacing it by air, as is done in the Government torpedo, but by displacing it by water mechanically pumped in; and

the idea of providing a mechanical regulator which will throttle down and actually check the supply of water delivered from the pump.

The officers of the Bureau of Ordnance could not have looked at this drawing and seen in it any resemblance to the Bliss torpedo which was running in the water. It is unnecessary to consider whether it is possible at the present time to build up a careful theory of equivalence based, not on "the device in question" or that "known as Steam Generator for Automobile Torpedoes," as shown in the drawing, but on the abstract, indefinite, and nebulous language of a patent claim which those officers never saw. The contract was not made on the basis of a desired equivalence of the language of a patent claim with the Bliss torpedo. It was made for "the device in question," as shown in the drawing, for the thing "known as Steam Generator for Automobile Torpedoes," without any reference to the claim of a patent which was not then in existence, and this drawing showed a device embodying radically different principles from the device then known to the Government and now utilized by it in the Bliss torpedo, a device which in its mechanical construction omitted the salient elements which in the Bliss torpedo had been added to the old Armstrong outside superheater to make a water-cooled superheater; that is, the separate water container and the duplicate system of piping, and which did embody a whole army of mechanical elements not utilized in that Bliss torpedo—a pump, a regulator throttling

the pump, an auxiliary reducing valve, and a piping system for displacing fuel with water. This was "the device in question," the device then "known as Steam Generator" to the parties, and it is not a device ever utilized by the Government except in the two converted Whitehead torpedoes in which it was installed by the plaintiff and for which the Government charitably paid.

It was represented to the court below that the Government entered into the contract at bar because the Electric Boat Company could offer it torpedoes having a much longer range than any torpedo the Government possessed or could procure. We have shown such were not the facts. We have shown (supra, p. 52) that at the time negotiations leading up to the contract were begun by the Electric Boat Company's letter of proposal, dated October 20, 1911, the Government had at the testing grounds the Bliss torpedo, a "practical duplicate" of the torpedoes now complained of (Finding XIII, last paragraph, p. 22), and this torpedo had already demonstrated its ability to run 10,000 yards. The Electric Boat Company's proposal related to torpedoes which were to run only 6,000 yards at a minimum and 8,000 yards at a maximum; and at that time the Electric Boat Company had never produced a torpedo. Plainly, the inducement which moved the Government to enter into this contract was not the expectation of obtaining torpedoes of increased or maximum range. Such torpedoes it already had. The inducement which moved the Government to enter into

this contract was, as we have shown (supra, p. 54), the expectation of being able by the addition of the specially designed "device in question" to bring the range of its old Whitehead torpedoes which were on hand up to something approaching the range of the new Bliss torpedo, which had made these old Whitehead torpedoes, having only a 4,000-yard range, obsolete weapons.

This is plain, not only from the surrounding circumstances, but it is made manifest by contemporaneous writings. Thus, in the first letter from the petitioner which initiated the negotiations which resulted in the contract at bar, the petitioner (Finding IX, p. 14), after saying that "we have developed A DEVICE which may be applied to *any automobile torpedo now in service*," offered to equip "one of the *existing* torpedoes," provided the parties could agree upon "a royalty to be paid on all torpedoes fitted with THIS DEVICE in the future." This offer was accompanied only by a blue print showing what "this device" was. The Bureau's reply (Finding X, p. 17) referred only to altering over existing torpedoes, and the petitioner in answering this letter, after saying that the terms mentioned were satisfactory, added that (Finding X, p. 17):

> It is our understanding that the royalty will apply not only to torpedoes which may hereafter be *converted*, but also to torpedoes which the Government may build at its own works and in which THE DEVICE IN QUESTION is to be used.

The Government accepted this condition and the contract at bar was executed. It is clear, therefore, that at the time of the execution of the contract it was the understanding of both parties that the royalty was to apply only to torpedoes in which "*the device in question*," then known to the Government only by the blue print which the petitioner had placed in its hands, should be used.

It was contended before the Court below that the offer of October 20, 1911, was a renewal of the offer of August 8, 1910, with different terms. This is refuted by the terms of the offer itself, by the situation of the plaintiff at the time, and by the manner in which the Navy treated it. Indeed appellant has abandoned this contention and does not refer to the letter in its brief, but since the letter appears in the findings of fact we may consider the point briefly.

In the letter of August 8, 1910, the plaintiff had told the Bureau that it "had developed a device for increasing the range of automobile torpedoes." It had a contract relating to that device and was working under that contract. Now, more than a year later, there was no reason to write again about the old subject matter. But it brought up new subject matter of which the Bureau of Ordnance had never heard and wrote that it had "developed a device *which may be applied to any automobile torpedo now in service*, which will more than double the range of *such torpedo*."

The old problem of the Navy, the problem of a long range torpedo, was in the past. But here was a new proposition, the proposition of converting the old Whiteheads by means of the specific device designed by the plaintiff. The Navy treated this as an entirely different proposition, as relating to a limited and transitory emergency. It did not organize a competition, as it had done when there was a question of developing a new torpedo. It dealt solely with the plaintiff for the particular thing the plaintiff offered. If it could use that specific thing which the plaintiff had, it would pay for it. If what the plaintiff had would satisfy its present need, it was not necessary to look further. But the contract contemplated solely that particular need and that specific device.

Not only does the correspondence between the parties before the contract at bar was executed definitely prove that the thing on which royalty was to be paid was "*the device in question,*" something shown, and then shown only, in a blue print or drawing submitted by the petitioner; but contemporaneous writings definitely prove that it was the affirmative understanding, both of the Government and the petitioner, that the agreement did not cover either the Bliss torpedo which the Government had in its hands at the time, or the water-cooled superheaters which the Government's engineers had been experimenting with for some time (Finding V, p. 11), or any form of water-cooled superheaters other than "the device in question" which was shown in the blue print submitted by the petitioner. Thus, when

the proposition of the petitioner came to the attention of Commander Williams, he strongly recommended that it be not accepted, because (Finding IX, p. 15) he feared it might be construed to cover the said Bliss torpedo (which it must be remembered was a practical duplicate of the torpedoes now complained of) and the water-cooled superheaters which the Government's engineers had been experimenting with. The Bureau of Ordnance replied to Commander Williams's fears by stating (Finding IX, p. 16) that it had been "*given to understand*" that the contract would not "*conflict with the present superheater rights*" of the Government. So here we have a contemporaneous writing setting forth the understanding of the Government as to what the contract was to cover, which understanding was based on the representations of petitioner. This understanding, since it was not changed before the contract was signed, is binding on both parties.

Furthermore, the language of the written contract is entirely in harmony with, and, indeed, pointedly emphasizes the understanding of the parties, as indicated in the correspondence between them and the endorsements thereon, that royalty was to be paid only on "the device in question," and was not to be paid on such torpedoes as are now complained of, which are "practical duplicates of" the Bliss torpedo which was in the hands of the Government before the Electric Boat Company's proposal was submitted.

The ordinary form of license under patents is given in the Rules of Practice of the Patent Office at page 90. This ordinary form, after reciting the patents, licenses and empowers the licensee to manufacture and sell devices "containing the patented improvements," and provides for the payment of license fees on devices "containing the patented improvements." The contract at bar, on the contrary, does not empower the Government to manufacture, and does not provide for the payment of royalties on "the patented improvements," but it recites that the subject of the contract is "*the invention* KNOWN *as Steam Generator for Automobile Torpedoes,*" and it provides for the payment of royalties "for each of the first ten torpedoes equipped with *the Steam Generator for Automobile Torpedoes,*" etc. The words "known as Steam Generator for Automobile Torpedoes" definitely identify the particular device shown in the blue print submitted by the petitioner, an invention in its embodied physical form, because so far as appears from this record, and so far as we know, this is the only device which at that time was known as a "Steam Generator for Automobile Torpedoes." The specific device shown in said blue print, the thing he had invented, was christened by Davison a "Steam Generator" and is constantly referred to by this name in the correspondence. It is a sort of trade name for his particular device.

At that time no one dreamed of calling the Bliss torpedo and other torpedoes utilizing injected water by any such name. The Government torpedo sta-

tion (Finding V, paragraph 7, p. 11; Finding IX, p. 15), the Bliss Company (Finding V, last paragraph p. 11), the Bureau of Ordnance (Finding V, 3rd paragraph, p. 10), and Commander Williams, the officer in charge of the Government torpedo station (Finding IX, p. 15), all speak of "superheaters," describing them as superheaters into which water is injected. The name "Steam Generator" was devised and used by Davison to identify the particular device which he himself had gotten up and which was shown in the blue print, and, in a simplified form, in the drawings of the patent in suit. The bureau was "given to understand that the generator" (i. e. Davison's Steam Generator) "is not in any sense a superheater" and "is not to conflict with the present superheater rights." (Finding IX, 2d paragraph, p. 16.)

So we see that the written contract does not provide for the payment of royalties on the "patented improvements," as patent licenses usually do, does not provide for the payment of royalties on "water-cooled superheaters," as it would have done if it had intended to cover the Bliss torpedo then in the hands of the Government; but provides only for the payment of royalties in case the Government should use the specific thing then "known as Steam Generator for Automobile Torpedoes," which was the thing which the Government then knew, and knew only, by the medium of a blue print which it had received from the petitioner.

What was *the thing* concerning which the minds of the parties met in the agreement? Can anything be clearer than that the thing was the device shown in the drawing received from the plaintiff which is referred to in the correspondence as "the device in question" and which is referred to in the contract as the device "known as Steam Generator for Automobile Torpedoes"? The drawing was the only thing which was before them. The "device in question," the thing "known as Steam Generator," was specifically designed to be applied to the old Whitehead torpedoes for the purpose of making them over; but it might be used in other torpedoes. *It was not a new device to be constructed from the ground up, a new torpedo from warhead to propellers, as was the new and successful Bliss torpedo which the Government then had in its hands.*

This interpretation of the contract, as one for the use of a specific device, is amply sustained by the decision of this Court in *Burdell* v. *Denig*, 92 U. S. 716. This was a suit for infringement of the Wilson patent for a feeding device for a sewing machine. The defendants set up a license granted under an assignment by the plaintiff of a territorial interest to defendant's licensor. This assignment was of the right to use "Singer's patent sewing machine as mentioned in the patent granted to Isaac M. Singer, dated August 12, 1905." It was contended that the plaintiff never had any interest in the Singer patent and that the machine known as the Singer machine at the time the assignment was made embodied the

Wilson feeding device, and that as the plaintiff did own the patent for that device, the assignment was of the right to use the Singer machine with the Wilson device. This Court said:

> It is certainly true that in construing a written instrument it is necessary and admissible to look to all the surrounding circumstances of the transaction which are necessary to discover its meaning. It may be admitted that if the facts above stated were conceded to be true it would follow that the reasonable construction of the contract would be such as the Court held it to be.
>
> * * * * *
>
> If the judge had said that if they (the jury) believed these facts to be established, then the license to Lowe authorized the use of the Wilson device in the Singer machine, we would affirm the judgment.

Comparing this with the case at bar we find in the latter that the contract is for the use of Davison's "Steam Generator for Automobile Torpedoes," just as in the case cited it was for the "Singer machine" as then known. The reference to patents, just as was the reference to the Singer patent in the case cited, is merely descriptive and not definitive. The reference to surrounding circumstances is equally necessary to determine the nature of the contract.

HARVEY STEEL CASE DISCUSSED.

The plaintiff has relied much upon the *Harvey Steel case* (38 Court of Claims, 662; 39 Court of Claims, 297; 196 U. S. 310). We agree with plaintiff's

counsel that the reasoning of the court in that case practically decides the issues in this case, but we say it decides them in favor of the Government and not in favor of the petitioner.

In the *Harvey Steel case* there was before the court a contract in which the Government agreed to pay a certain sum for the use of a specific thing, to wit, the "Harvey process," a description of which had been supplied to it. The Government had concededly and avowedly used that specific thing, but because the contract described the thing by reference to a patent, the Government contended that it should not pay the contract price because the patent was either invalid or was not infringed. In the instant case the Government has agreed to pay a certain sum for the use of a specific thing, to wit, the thing that was then "known as Steam Generator for Automobile Torpedoes," a drawing of which was supplied to it. The Government has never used that specific thing, but because the contract described that specific thing by reference to patent applications, which the Government never saw, the plaintiff here contends that the Government must pay the contract price if the nebulous terms of a claim in one of the patents referred to can be read upon what the Government has used, and is using, although that thing was not, at the time the contract was made, "known as Steam Generator for Automobile Torpedoes," but was always referred to as a superheater, and is, indeed, something which the Government had in

its hands and had obtained from a rival before negotiations leading up to the contract were begun.

The beginning, the middle, and the end of the decision of the Supreme Court in the *Harvey Steel case* is that when there is a contract to pay a royalty for the use of a specified thing, even when it is described in the contract by reference to a patent, the royalty must be paid if the specified thing is used, even if the claims of the patent do not cover it. There can be no doubt of what the doctrine of the case is, because in *U. S.* v. *Harvey Steel Co.*, 227 U. S. 165, this Court explained its decision in 196 U. S. and said that "The questions presented and decided were (*a*) whether under the contract of 1893 the United States could set up the invalidity of the patent as a defense, and (*b*) whether the United States ought to have been allowed to show that it had not used the patent, properly construed, although it had used 'the process communicated to it and known in common speech as the Harvey process'" (p. 168); and again, "This decision plainly refutes the contention now again urged that the Harvey process of the contract of 1893 is limited and strictly confined to the method of the patent, and it is here controlling. Furthermore, in no possible view do the findings in the present case present facts which even suggest the possibility of a different construction of the contract than that heretofore given," (p. 170.) The case has also been summed up by the Circuit Court of Appeals for the Second Circuit in *Pressed Steel Car Co.*v. *Union*

Pacific Ry. Co., 270 Fed 518 at 524, in the following language:

> As to the *Harvey case*, what the court held in the first case was that the government's defense that it was not using the patented process was bad, even though it used a lower heat in making armor plate than the patent called for, because it was using the process known as the Harvey process, which was the actual process it had contiacted for.

If then where the contract is to pay royalty for a specific thing the royalty must be paid when that specific thing is used, even if a patent referred to in the contract does not cover it, the converse of the proposition must be equally true. Therefore, when, as here, there is a contract to pay a royalty for the use of a specified thing, even when it is identified in the contract by reference to a patent, the royalty is not due if the specified thing is not used, even if the claims of the patent do cover it. In this case the specified thing on which it was agreed royalty should be paid was the device then "known as Steam Generator for Automobile Torpedoes," which device was shown in the blue print submitted by the petitioner, and nobody contends the Government has ever used that specific thing.

This case would be like the *Harvey Steel case* if the Government had used the device shown in the blue print submitted by the petitioner, and was here claiming immunity because the claims of the patents referred to in the contract did not cover it or are invalid. We do not deny that the claims of the

patent cover the thing shown in the blue print submitted by the plaintiff which, at the time the contract was signed, was "known as Steam Generator for Automobile Torpedoes," or that, so construed, the claims are valid. What we deny is that the Government has ever used the Davison device of the blue print which was then "known as Steam Generator for Automobile Torpedoes"; and nobody here contends that it has done so. The only device the Government has ever used is one which no one could then ever have identified by saying that it was "known as Steam Generator for Automobile Torpedoes," but is one which was always known as a water-cooled superheater, and one which the Government procured from the Bliss Company and had in its hands before negotiations which led up to the contract at bar were begun.

The *Harvey Steel case*, while thus representing in one sense the exact obverse of the present case, in another way differs entirely therefrom. There is no element of estoppel in the present case. In the *Harvey case* the process in question was revealed to the Government under the terms of the contract. So here the device of the plaintiff's steam generator, as shown in the drawing, was revealed to the Government. Here the resemblance ends. The Government ordered armor plates from other parties and specified that they should be treated by the "Harvey process," and informed the contractors that they should not pay royalties because the Government had a license. Here the Government has never

done anything with the information furnished them by the plaintiff after they gathered at a late date the further information that the plaintiff's device was impracticable. Instead, they went ahead ordering not the plaintiff's device but the Bliss device, which they had had before they received any information from the plaintiff.

In the *Harvey Steel case*, after ordering plates to be made by "the Harvey process," the Government attempted to deny that these plates made in accordance with the specifications of the Harvey process were within the terms of the contract, because it alleged that they were not within the terms of the patent referred to in the contract. This was a true estoppel *in pais*. The Court of Claims said in its opinion, 38 Court of Claims, 662 at 685, affirmed by this court, 196 U. S. 310:

> A plainer case of estoppel never came before a court. The defendants first bound the claimant's hands by a contract which secured the right to themselves to use the invention and precluded the claimant from prosecuting the manufacturers as infringers. They next closed the claimant's eyes as against the manufacturers by advertising that the plates to be made were to be treated by the "Harvey process" and that "the prices must not include anything for royalties, as the department has acquired the right to use said process, and will indemnify the contractor against all claims therefor." They did not rescind the contract or give a notice which would have put the claimant on its guard, or enabled it to pro-

ceed against the manufacturers, but stood silent until the work was done and they had received the fruits of their agreement. Having received every possible benefit, they now seek to evade its obligations.

How different is this situation from the circumstances of the present case. Here the Government derived no knowledge as to the torpedo now complained of from the plaintiff. The prototype of the present torpedo was running 10,000 yards in the water before the Bureau of Ordnance ever saw the drawing which formed the basis of the contract. The United States has never held out that this torpedo, or those like it which have since been built, is the Davison invention or is "known as Steam Generator." It has put no impediments in the way of the plaintiff prosecuting any rights that it may believe it has against manufacturers of this torpedo. The United States has ordered duplicates of a torpedo which was known to it and was in its possession before the subject of the present contract was broached. Thereafter, in connection with an entirely distinct project—the conversion of Whitehead torpedoes—the United States entered into a contract with plaintiff. This contract was for the Davison "Steam Generator." The Government has never used the Davison "Steam Generator." In the *Harvey Steel case* it ordered plates as "Harvey plates" and then attempted to deny that they were "Harvey plates." In the present instance it has continued to make and have built Bliss water-cooled superheaters and it is no way estopped *in pais* to say that these super-

heaters are not Davison's "Steam Generators" but are embodiments of the prior art and not the invention of the plaintiff's assignor.

The patent claims never defined the scope of the contract.

It has been shown (supra, p. 62) that the device contracted for was a specific organization identified by a drawing and that the contract was not generally for any device within the scope of the claims of the patent which was to issue in the future. Apart from the positive proof afforded by the actions of the parties and their written statements in the correspondence which is in evidence and the language of the contract itself, it furthermore is clear, as a matter of general principle, that the terms of the claims as they now exist in the patent, granted months after the contract sued on, are not part of the contract and do not determine its scope or define the devices on which the Government is to pay royalty.

The contract, in so far as it refers to the patent in suit at all, differs radically from the ordinary patent license, because the patent was then a pending application, a secret record of the Patent Office, a mere claim of a right and no grant of a monopoly on behalf of the Government, and was still indefinite and unformulated. In the usual contract of license under a granted patent the licensee is bound by the terms of the patent claims and he is even held precluded from denying the validity of such claims. The reason is simple and clear. He contracts for rights under a patent, a definite and fixed document,

granting a limited monopoly, the metes and bounds of which are defined by the terms of the patent claims. Either he knows actually what bounds those claims place on the monopoly or he is charged with such knowledge, because the patent is a public record of of which all the world is charged with notice. With his eyes open he makes his bargain and is held to his bargain.

In the case of a patent application, however, no monopoly is granted and no metes and bounds are placed on that monopoly. The application leading to the patent is a secret record of the Patent Office controlled solely by the patentee and his privies. In the present case the defendant was not shown the patent applications of the Electric Boat Company (Finding X, last paragraph, p. 20), and the record will be searched in vain for any offer of the Electric Boat Company to apprise the Ordnance Bureau of the contents of those applications. The intention of the Navy Department is made clear by that action. They disregarded the patent applications because their contract was for a specific thing and not for general rights under patents.

If this were a contract for the use of an invention, even if we overlook the fact that by "invention" reference was made to the physical device shown by the drawing which the parties had under consideration, what did it cover? Did it cover anything within the terms of a patent claim subsequently granted irrespective of the actual validity of that claim? Obviously not. Suppose the plaintiff's patent had issued with a claim saying nothing more than the

words "An automobile torpedo." Could the plaintiff have come before this court and asked royalty for every automobile torpedo manufactured by the United States? If the United States had bound itself in advance to accept as the terms of its contract everything that the Patent Office might grant, it might be liable, subject only to relief in equity on the ground of undue hardship. But it did not do that. The most that can be said for the contract from the Electric Boat Company's point of view is that Mr. Davison had a novel invention and that the United States contracted for the use of the thing which was novel.

The claims allowed by the Patent Office are supposed as a matter of fact to define for those who read the patent what is in fact novel. They do not always do so with accuracy, and when the contract was entered into in the present instance the parties did not have this finding or adjudication of the Patent Office to serve as a basis for their agreement. Novelty could mean to them only what was, as a matter of fact, novel in the disclosure which Mr. Davison had made in his applications and not what the patent examiner believed was novel. If their contract is to be interpreted and the scope of that novelty determined, the scope must be determined by this court or some other court of competent jurisdiction and not by the examiners of the Patent Office acting *ex parte* and before whom the defendant had no representation. If the parties made a contract for something which was novel, your honors can not be ousted of

your jurisdiction by the fact that at a later time the examiner in the Patent Office made a statement that such and such was novel.

This obviously correct view of the matter is amply sustained by the decision of the Supreme Court in *Eclipse Bicycle Company* v. *Farrow* (199 U. S. 581). In that case, as in this, a license was granted under a pending patent application, although the licensee was in a much less favorable position than is the Government in the present instance, because it had undertaken to exploit and develop the invention. Nevertheless, the court held that it was not liable under the contract as to structures not embodying the actual invention of its assignor. The court said, (at page 588):

> On the other hand, the contract was not made on the footing that no coaster or no combination of coaster and brake ever had been invented, and that the whole field belonged to Farrow. Both parties knew something of the state of the art. The very facts which show that they stood on an equal footing and that the company was not deceived by Farrow show that. The contract shows the same thing on its face. It recites that Farrow has invented, not a mechanism for coasting and braking, but an improvement pertaining to such mechanism. It was a contract having definite reference to the course of the Patent Office, and was for the contents of the application already filed. The application recognizes the existence of coasters. So that *the contract only embraces what the parties reasonably may be understood to have expected to be patented.*

On page 586:

> The real questions in the case are whether the first mentioned Farrow device and the subsequent E 10 fall within the scope of the contract, and these questions depend more upon a careful construction of that instrument than upon nice discriminations between the patents that were or might have been issued. If either of the contrivances used embodies the invention described in Farrow's applications, then the defendant is bound to account for it by the express terms of its covenant, unless the contract is at an end.

And again, on page 591:

> In this case, as in the former, a general indication of the nature of the device is sufficient on the question whether the latter embodies the former in the sense of the contract. This question is answered by the description which we have given. It is true that in both the sprocket wheel is arranged to engage or disengage with the main wheels of the machine, to allow coasting and to brake by a reverse action of the rider's feet. But the methods by which these results are accomplished are so different that it is only on the assumption that Farrow was in the broadest sense a pioneer, and had covered the whole ground, or at least that the contract put him in that position relatively to the defendant that the claim in respect of E 10 could be allowed. It is not pretended that Farrow occupied such a position as an inventor, and our construction of the contract does not give it the sup-

> posed extent. The auditor found that there was a radical difference between the contrivances in construction and operation, and there has not been and could not be a finding to the contrary.

In the present instance it was well known to all parties that the principle of injecting water into the combustion chamber of the torpedo was not new. Davison recognized it when he stated in his patent specification that his invention which was to be patented was for an apparatus suitable for carrying out the principle. What could the parties reasonably have expected to be patented? The Government certainly could not have believed that Mr. Davison with his pump, his regulator chamber, his auxiliary reducing valve, and half a dozen other devices was displaying to them a novelty including the Bliss torpedo which they knew about before the Davison device was submitted to them. The invention, using that word in its sense as the intangible mental conception, was the actual novelty displayed by the disclosure of the pending application, in view of the existing state of the art as shown, in part, by the printed publications existing before Mr. Davison's conception. These printed publications included the patents to Sodeau and in particular the British patent 6081 of 1907.

As we show later (infra, p. 112), the present Government torpedo is in its principles and essentials the Armstrong-Whitworth superheater disclosed by these patents, invented by Sodeau, the assignor to

Armstrong, Whitworth & Company, built as Sodeau had designed it for use with two liquids, fuel and water. It is an embodiment of the prior art existing in printed publications before Mr. Davison's invention. It simply was not novel at the time Mr. Davison made his invention, at the time the patent application was made and at the time the contract was entered into, and it could not have been anticipated that any patent to be granted on Mr. Davison's patent application should include and cover the prior art as disclosed in the Sodeau publications, any more than it could have been anticipated that it would include every automobile torpedo.

When the parties contracted for rights under a pending patent application, the scope of the contract was not defined by the form which the Patent Office would later give to the patent when it was granted. The utmost they could have contracted for was the novel features embodied in the patent applications, the actual novelty. The device which the Government now makes is an embodiment of prior-art publications, not novel at the time Davison conceived of the device which he patented; and not within the terms of the contract.

THIRD SECTION OF THE BRIEF.

THE CONSTRUCTION OF TORPEDOES—THE INVENTIVE DEVELOPMENT THEREOF, THE PATENT IN SUIT AND ITS INTERPRETATION.

We have already indicated our view that a full understanding of the technical questions involved in the several structures can only be obtained by examination of the evidence which is not before this

court, and upon which the lower court reached its finding of fact that the defendant has not manufactured or used plaintiffs device. We shall in this section of the brief, however, endeavor to make the explanation as clear as possible from the papers forming part of the findings.

FIRST STEPS IN TORPEDO DEVELOPMENT.

The first steps in the development of the torpedo power plant may be very briefly reviewed. We should, however, recall that in the early history of the art the other features of torpedo construction were receiving development and attention, and only after such points as depth control and direction control had been mastered did the question of a large increase in the range become acute. It is useless to have a weapon which will shoot five miles unless it will go straight enough to hit the target.

The early torpedoes were operated with compressed air engines. Air was stored in the so-called air flask of the torpedo under a very high pressure for reasons of space economy, and released to the engine through a reducing valve which permitted the air to escape at a substantially constant reduced but still high pressure. This so-called "low pressure" air, being under a considerable pressure, could expand and perform useful work in the engine before it was exhausted therefrom.

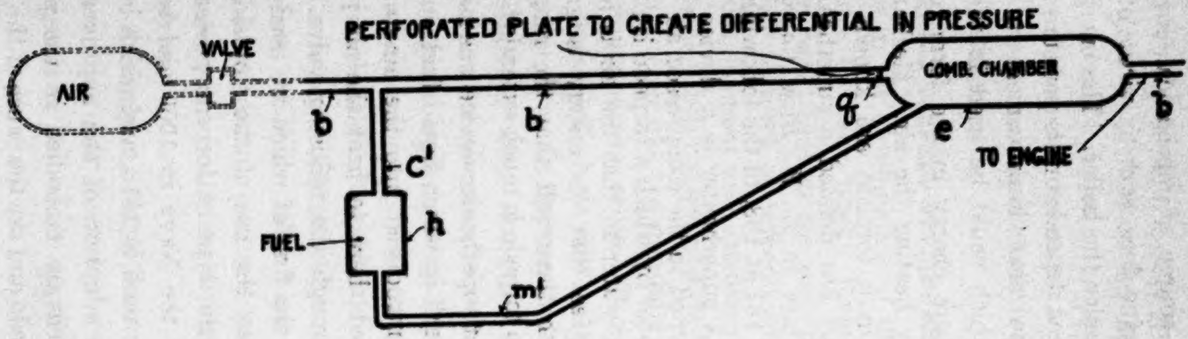
The amount of energy available from cold compressed air was limited and there were other disadvantages not necessary to dwell upon here. The

ordinary source of mechanical energy is heat. A steam engine does work by virtue of the coal that is burned under the boiler. The energy available in a body of gas depends on its pressure and its temperature. The next improvement to obtain greater energy which could be used in the engine was to supply more energy in the form of heat units by artificially heating the air. Mechanisms for effecting this in a torpedo are known as superheaters. This Court has defined a superheater through Mr. Justice Clark in *E. W. Bliss Co.* v. *United States*, 253 U. S. 187 at 188, in the following language:

> A superheater is a device in which fuel is burned in the compressed air which drives the motor by which a torpedo is propelled through the water so that the air is heated to such a degree that its energy is greatly increased, with the result that the range of the use of the torpedo is much extended.

The first superheater device was a so-called "inside superheater" in which liquid fuel, such as alcohol or oil, was introduced into the air-storage tank itself and burned there to heat the air just prior to its release through the reducing valve. The following step, and the first of which we need to consider the details, was the use of the "outside superheater." This was the type of torpedo power plant first obtained by the Navy in 1909 and which was being practically used in 1910, and which immediately preceded the adoption of the improvements in power plant which are embodied in the present Government torpedo and are the cause of the present suit.

FIG. 2. U.S. PAT. TO SODEAU 835,262 OF 1906



There is reproduced herewith Fig. 2 of the drawing of the United States patent to Sodeau, 835262, of November 6, 1906 (Exhibit C–7, record, p. 22), which is reproduced in the addition to record following page 47. This represents diagrammatically the Armstrong outside superheater power plant as used by the Government in 1910 and which is described in Finding IV, p. 9. (Appellant's brief, p. 67.) In these torpedoes with outside superheater air stored under high pressure in a reservoir was released through a reducing valve, which provided throughout the run of the torpedo a supply of air at substantially constant pressure, which air was passed to the engine through a combustion chamber *e*. This combustion chamber *e*, exterior of the air flask, is a characteristic feature of the outside superheater, whether simple, as here shown, or water-cooled, as in the present types of torpedoes. In this chamber the air was heated before it passed to the engine by burning fuel therein. The fuel, contained in the tank *h*, was sprayed through pipe *m′* into the combustion chamber, being displaced from the tank by a portion of the low-pressure air admitted to the surface of the fuel through pipe *c′*. To permit the fuel to be displaced in this manner the pressure in the combustion chamber had to be less than the pressure on the top of the fuel in the tank *h*, and a lower pressure in the combustion chamber to provide for such differential in pressure was obtained by placing a perforated plate or restriction ring *q* in the main pipe leading to the

combustion chamber between that chamber and the branch c'. This caused a lower pressure to exist in the combustion chamber and the fuel was thus fed from the tank under the influence of the difference between the two pressures. As pointed out in the patent, the rate at which the fuel was supplied to the combustion chamber could be controlled by proper arrangement of the size of the openings through which it was discharged therein.

It is pointed out in the official report relating to the Government's experiments at the naval torpedo station at Newport, which report is partly quoted in Finding V, pages 10 and 11, that the amount of fuel which could be burned in a device of this character, and consequently the amount of heat units that could be utilized in the engine to turn out useful work, was limited practically by the high temperatures which would result and which, if too high, would destroy the metal parts of the apparatus. The present practice provides for a greater supply of energy—that is, a greater supply of heat units—with a reduction of the excessive temperatures through an injection of water into the combustion chamber, which cools down the products of combustion to a permissible temperature but makes available the surplus heat units through the vaporization of the water which passes to the engine in the form of steam. We thus have a water-cooled superheater. Useful work is obtained by burning a large amount of fuel to provide a large number of heat units, since heat is a form of energy, and a portion

of these heat units are made available through the medium of cooling water vaporized as steam. The idea, however, is not to make as much steam as possible, but to use all the heat units possible. For a given amount of fuel, the less water used and the higher the temperature obtained within permissible limits the greater the efficiency. In the present torpedoes of the defendant the motive fluid comprises the nitrogen of the air and also the products of combustion (in which products is included some or all of the oxygen of the air) and a certain amount of steam generated from the cooling water.

DISCLOSURE OF PRINCIPLES OF WATER INJECTION.

The principle of operating an engine with the gases produced by burning a large amount of fuel in air or oxygen with the addition of water was suggested at an early date. In fact, as we shall later point out, Davison in the specification of the patent in suit (record, p. 25) refers to it as a well-known thing, and states that his purpose is to provide a mechanism suitable for carrying out the principle and one safe to use in torpedoes.

In 1910 the mechanical constructors had pushed the outside superheater to its perfection, understood its limitations, and were ready to turn to and develop the water-cooled superheater and, as the story hereinbefore recited shows, not only the plaintiff company, but the E. W. Bliss Company, the United States Navy on its own account, and foreign powers had all commenced work on the next step of torpedo development—that is, the water-cooled superheater.

De Ferranti patent.

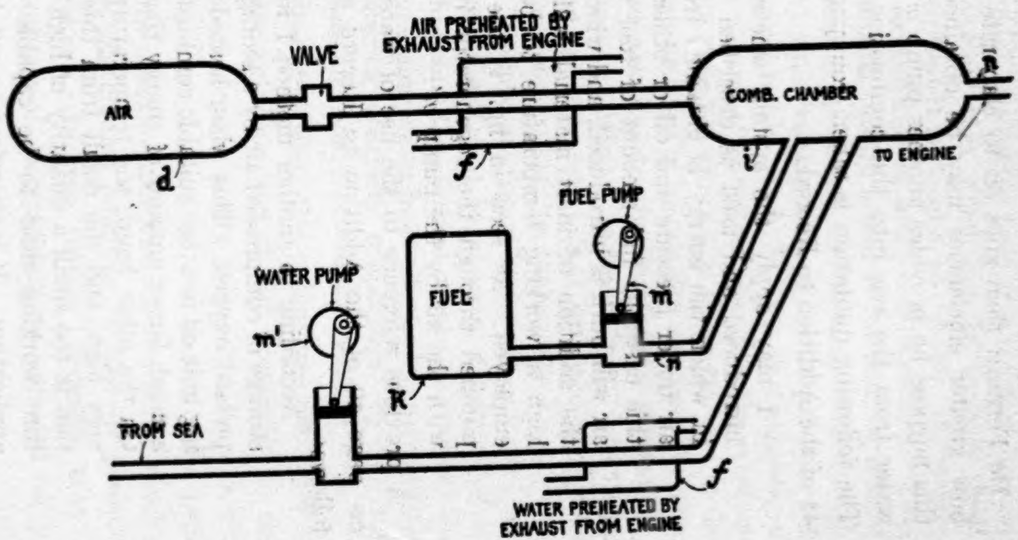
A complete exposition of the thermodynamic principles of a torpedo power plant and a full explanation of the efficiency which would be obtained by the use of water therein was given by the famous electrical engineer, De Ferranti, in his British patent No. 9946 of 1904, Exhibit C-5, which was issued as a printed publication on August 17, 1905. (Finding XIV, p. 22.) This patent is reproduced in the Addition to Record (p. 38). There is shown herewith a diagram of the De Ferranti torpedo in which the same reference numerals are employed as are used in the patent.

De Ferranti explains that his invention is especially suitable for the propulsion of automobile torpedoes and shows the air chamber *d* and the reducing valve of usual type. He first describes a form of outside superheater. Thus he states (Addition to Record, p. 39):

> Instead of feeding these torpedoes with working fluid in the shape of cold air derived from the storage of compressed air, *d*, carried in the torpedo, I first lead the air * * * to the combustion chambers, *i*, in which the air is raised to a high temperature such as 1200° C. or thereabout by burning in it a small amount of oil or like fuel, for example, stored in a reservoir, *k*.

This fuel was to be pumped in by a pump *m* driven from the engine but De Ferranti also states, " As an alternative the pump *m* may be dispensed with and

DeFERRANTI BR. PATENT 9496 OF 1904



the oil forced into the combustion chamber entirely by the compressed air."

De Ferranti then goes on to elaborate and show how greater efficiencies may be obtained and for this purpose he provides another pump *m′* to pump water from the sea into the combustion chamber. The following quotation is taken from pages 41 and 42 of the Addition to Record:

> I may apply the system where water is introduced and used as described to motors in which the energy is obtained from stored air under pressure and oil or other fuel. In this case the full amount of fuel which the air will burn is introduced, and which without the addition of inert material will give too high a working temperature to be usefully employed. As seen in fig. 1, the water is pumped through the regenerator in parallel with the air by the pump *m′*.

A previous reference to the use of water appears on page 40 of the Addition to Record and is as follows:

> According to another method I replace the storage of compressed air by a storage of compressed oxygen. This when heated by burning in it oil or other suitable combustible gives a much larger amount of energy than the air. On the other hand, the temperature given is very high, and the result from this combustion is too small a quantity of high temperature working fluid to be capable of useful application. It is therefore essential with this

> method to introduce sufficient medium, which may be of an inert nature, to give the full amount of working fluid at a temperature not exceeding that which can be usefully dealt with that it is possible to get from the weight of oxygen and oil which can be carried. I accomplish this by means of introducing a fixed quantity of water, and mixing, evaporating, and superheating this so as to produce the desired result. * * * It is then discharged by means of spray nozzles into the combustion chamber where it is atomized, due to the high velocity of issuing through small orifices, and also due to the heat which it contains, which is sufficient to break it up into steam and so intimately mix it with the gases that complete evaporation takes place.
>
> The heat contained in the water under pressure is sufficient to vaporize a portion of it. The steam thus formed internally atomizes the remaining water most effectually, thus greatly assisting complete evaporation by the hot gases and final mixture therewith.

It is clear that when this patent was published in 1905 every principle and theory applicable to the operation of torpedo power plants like those under discussion was disclosed to the public. The principle of the outside superheater in which fuel was fed either by mechanical pump or by the air pressure was disclosed. It was further disclosed that a greater output of energy could be provided for by

burning all the oxygen in the air with fuel and utilizing the energy thus created, while avoiding excessive temperatures by introducing water. Still further De Ferranti points to the possibilities of using compressed oxygen, which for a given volume would permit more fuel to be burned, describes the economy which might be obtained by utilizing the exhaust of the engine to preheat the air and water in the preheater *f* just as in the ordinary steam engine the feed water is heated by exhaust steam for economy in operation, and discusses many other possibilities.

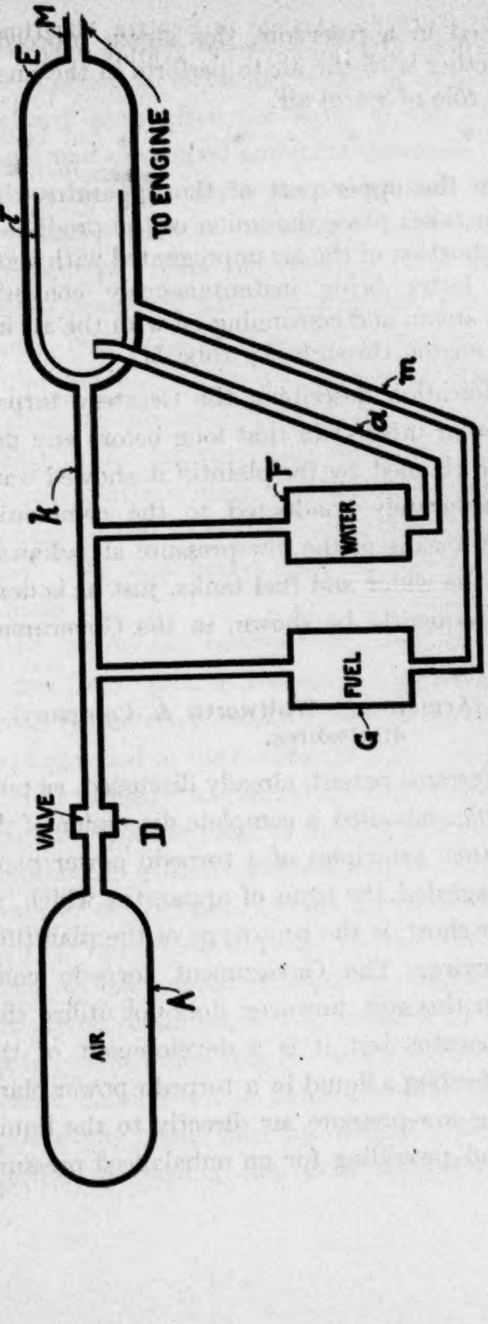
After this patent was published in 1905 there was no longer anything novel in the idea that torpedoes could be driven by a motive fluid produced by burning fuel with an oxygen carrier, and in particular the greatest possible amount of fuel for a given quantity of oxygen, and adding water for the double purpose of keeping down the temperature of the gases and providing another constituent for the motive fluid in the form of steam. This idea originated neither with the defendant nor with Davison, and Davison in his patent recognizes this fact and in the first part of that patent specification clearly states that the use of water would be desirable "provided an apparatus can be devised which is of the requisite simplicity in construction and regulation," and further states that "it is the object of the present invention to provide an apparatus suitable for the purpose."

As we will later show, the apparatus designed by Davison is a direct development of the particular apparatus disclosed by De Ferranti, whereas defendant's torpedo, while utilizing similar thermodynamic principles, utilizes an apparatus entirely different in form and character and developed along other lines.

Gesztesy Torpedo—Article in Revista Maritima Brazileira of January, 1908, Exhibit C-14.

We will next refer briefly to the Gesztesy torpedo, not because it is next in point of time, but because the publication describing it was studied by the defendant's officers more than two years before anything was learned by them of the plaintiff's work (Findings V and VI), long before the contract in suit was proposed, and fully a year before Davison's patent application was filed in March, 1909. The article in the *Revista Maritima Brazileira* describing the Gesztesy torpedo is Exhibit C-14 and was published in January, 1908 (Finding XIV, p. 22), and came to the attention of the Bureau of Ordnance in March of that year. The article is reproduced in the Addition to Record (pp. 63 and 35), and in the annexed diagram the combustion chamber has been swung around to a horizontal instead of a vertical position to correspond with the other diagrams. The Gesztesy device, as characterized by the Court in its findings of fact (Finding V, p. 10), provides "for the generation and use of steam in combination with compressed air and the gases of combustion for motive power" and adds to the outside superheater torpedo with the fuel tank G and its system of piping a separate tank F for water. Air is admitted to the water tank and forces the water into the combustion chamber in the same way as the fuel is forced. The following quotations are made from the Revista article:

> The purpose of the Gesztesy warmer is to quickly convert into steam the water con-



GESZTESY TORPEDO
REVISTA ARTICLE OF JANUARY 1908

tained in a reservoir, this steam proceeding together with the air to perform in the engine the rôle of warm air.

* * * * *

In the upper part of the apparatus there then takes place the union of the products of combustion of the air impregnated with water, the latter being instantaneously converted into steam and continuing on with the air into the engine through the tube M.

This publication describing the Gesztesy torpedo is of particular interest in that long before any date of invention claimed by the plaintiff it showed water and fuel separately conducted to the combustion chamber by means of the low-pressure air admitted directly to the water and fuel tanks, just as is done, as will subsequently be shown, in the Government torpedo.

Sodeau (Armstrong, Whitworth & Company) disclosures.

The De Ferranti patent, already discussed, as published in 1905, embodied a complete discussion of the thermodynamic principles of a torpedo power plant and also suggested the form of apparatus which, as we will later show, is the prototype of the plaintiff's patented device. The Government torpedo complained of in this suit, however, does not utilize this type of apparatus but it is a development of the principle of feeding a liquid in a torpedo power plant by admitting low-pressure air directly to the liquid container and providing for an unbalanced pressure

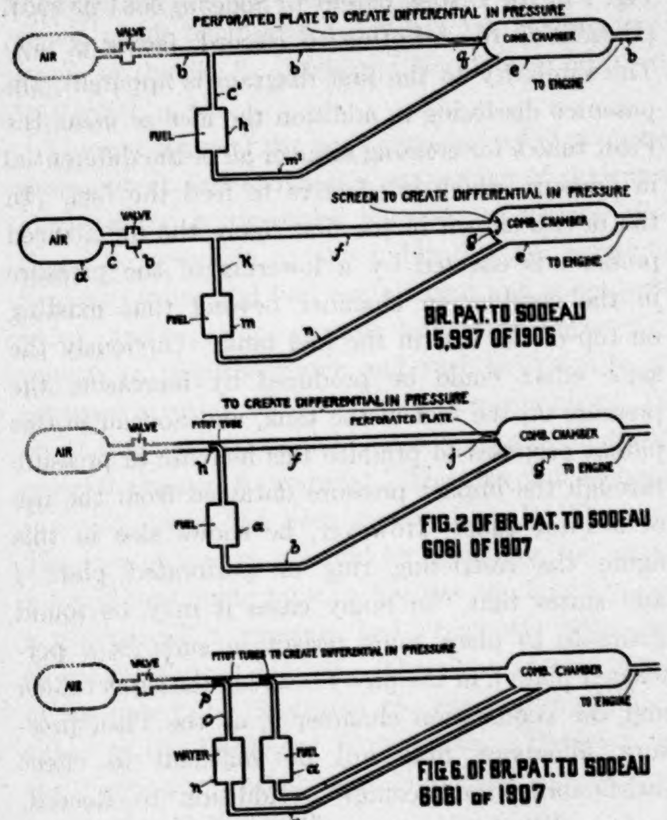
which will permit the air to displace the liquid into the combustion chamber, which principle was first disclosed soon after the issue of the De Ferranti patent and developed and made practical, first in the old outside superheater torpedoes and later in the defendant's present torpedoes with water-cooled superheaters. This development was due to one Sodeau connected with the munition works of Armstrong, Whitworth & Company of England. Certain British patents, which will here be referred to, were granted in accordance with the British practice jointly to this company and to the inventor, Sodeau, whereas corresponding United States patents were granted to the individual and assigned to the company. We will herein refer to these as "Sodeau patents."

We reproduce herewith in diagram form four figures from three of the several patents to Sodeau, which respectivley constitute Exhibits C-7, C-8, and C-10 annexed to the findings of fact. The first figure is that already explained in connection with the diagram opposite page 93 and represents the outside superheater wherein fuel was fed to the combustion chamber of a torpedo by the action of the low-pressure air admitted directly to the fuel containing tank, an unbalanced pressure or differential in pressure being produced, in this instance by a perforated plate or restriction ring *q*. It will be noted that this patent, Exhibit C-7, is dated 1906, the United States application being filed on August 21, 1905. This method of feeding fuel in a torpedo power plant

by the direct action of the air under a differential in pressure, utilized by defendant in its present torpedo, thus came after the suggestions of the De Ferranti patent and disclosed to the public a principle, method, and apparatus whereby not only could fuel be fed, as disclosed in the Sodeau patent itself, but any number of liquids, for instance, both fuel and water, as suggested by De Ferranti and as later disclosed by Sodeau himself, as will presently appear.

In the first figure shown in the diagram the air flask and valve are drawn in in dotted lines, as they do not appear in the drawing of the patent itself (Addition to Record, following p. 47). The device, however, is described in the patent specification as "an apparatus suitable for torpedo propulsion," and the use of the usual air flask and valve would not only be understood by those skilled in torpedo construction, but was clearly disclosed by Sodeau himself in his British patent of 1906, shown in the second figure in the diagram. This second figure of the diagram is a simplification of the British patent 15997 of 1906 (Exhibit C–8, reproduced in the Addition to Record, p. 48) and is inserted here for the purpose of showing that the same patentee (Sodeau) clearly disclosed to the public how the combustion chamber and the differential pressure means, as shown in his United States patent and in his later British patent next to be referred to, were to be assembled with the well-known air flask and reducing valve. The feed of the fuel is effected in this patent in substantially the same way except that the un-

FIG. 2. U.S. PAT. TO SODEAU 835,262 OF 1906



BR. PAT. TO SODEAU 15,997 OF 1906

FIG. 2 OF BR. PAT. TO SODEAU 6081 OF 1907

FIG. 6. OF BR. PAT. TO SODEAU 6081 OF 1907

balanced pressure on the fuel is secured by different means, in part by the perforated screen *g* instead of the orifice plate or obstruction *q* of the earlier patent.

The third diagram represents a disclosure of Fig. 2 of the British patent to Sodeau, 6081 of 1907. (Exhibit C-10, Addition to Record, facing p. 50.) The similarity to the first diagram is apparent, the patentee disclosing in addition the idea of using the Pitot tube *h* for creating some or all of the differential in pressure which is effective to feed the fuel. In the device shown in the first figure the unbalanced pressure is effected by a lowering of the pressure in the combustion chamber beyond that existing on top of the fuel in the fuel tank. Obviously the same effect could be produced by increasing the pressure on the fuel in the tank, and Sodeau in this patent proposes to produce this increase in pressure through the impact pressure obtained from the use of a Pitot tube. However, he shows also in this figure the restricting ring or perforated plate *j* and states that "in many cases it may be found desirable to place some resistance, such as a perforated plate *j*, in the pipe *f* between the Pitot tube *h* and the combustion chamber *g*, as the Pitot pressure difference may not be sufficient to effect satisfactorily the feeding." (Addition to Record, p. 51.) What Sodeau was patenting—that is, what he was claiming as his invention as distinguished from what he was disclosing to the public—was the idea of utilizing the phenomenon known as Pitot effect either to feed or to aid in feeding liquids in a

torpedo power plant whether fuel as in the outside superheater of his United States patent shown in the first figure of the diagram or, as will presently appear, both fuel and water as in the defendant's present water-cooled superheater. In the words of his claim he disclosed "means for feeding fuel, water, or the like." (Claims of the patent, Addition to Record, p. 53.)

The last figure of the page reproduces Fig. 6 of the same patent and shows the application of Sodeau's ideas to the water-cooled superheater already disclosed in principle to the public by De Ferranti. Separate water and fuel containers *a* and *n* are provided, and separate conduits lead air to these containers to displace water and fuel individually as separate streams to the combustion chamber. To effect this feeding, an unbalanced pressure or differential in pressure is produced. The idea of using both fuel and water had been disclosed by De Ferranti. The idea of feeding a liquid by admitting the air to a liquid-containing tank to displace the liquid under a differential in pressure had previously been disclosed by Sodeau himself. Therefore, in this figure of his patent, he illustrated the adaptation of Pitot tubes to the feeding of both liquids. However, in the description (Addition to Record, p. 52), he says in referring to this figure:

> The feeding of water or the like may, of course, be aided by means of a resistance in the path of the main air stream as in the case of feeding the fuel.

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The latest of the Sodeau patents just referred to, British patent 6081 of 1907, was published as a printed publication on April 23, 1908. (Finding XIV, p. 22.) This is months before any date of invention claimed by Davison who did not file his patent application until March, 1909. Long before Mr. Davison had conceived of the ideas embodied in his patent and years before he and the plaintiff company ever produced anything which might charitably be called a torpedo, Sodeau had disclosed to the public through printed publications the entire principles of an apparatus which as a matter of fact corresponds in all respects to defendant's present torpedo now complained of.

What the public learned from Sodeau is represented by the second diagram herewith reproduced facing page 114 in contrast with a diagram of defendant's torpedo. Here is a torpedo power plant with an air chamber and reducing valve which admits the air to the main conduit leading to the combustion chamber. Separate fuel and water containers *a* and *n* are provided and separate conduits lead air to these containers to displace the water and fuel individually as separate streams to the combustion chamber. This feeding, in accordance with Sodeau's invention embodied first in the Armstrong outside superheater, is effected by creating a differential or unbalanced pressure on the liquids in the tanks. Obviously those skilled in the art might select such means of producing

such a differential as they might choose or believe would be efficient. A Pitot effect could be utilized, as shown in Fig. 6 of the patent. If this were not sufficient, as the patentee himself points out, it could be aided by a perforated plate or restriction ring in the main air conduit. Both these devices could be used in combination just as they were shown in Fig. 2 of patent 6081 of 1907, the third figure of the preceding diagram, and as there described in connection with Fig. 6, the fourth figure of the diagram. In the contrast diagram herewith which shows also the Government torpedo both means are shown in accordance with the printed description in the patent of how the structure of Fig. 6 could be modified. To control the rate at which the liquids are fed, Sodeau described in his United States patent a proper proportioning of the openings through which they are discharged to the combustion chamber. Given a differential in pressure sufficient to overcome the resistance in these openings, and the small difference in effective level between the position of these openings and the surface of liquid in the tanks (and it will be recalled that a pound of pressure will sustain a 2-foot column of water), it is a mere engineering problem in designing the exit openings to discharge into the combustion chamber a given amount of fuel and water.

The De Ferranti patent, published several years earlier, had described using the greatest amount of fuel which the air would burn and injecting water to bring the products of combustion to a permissible

temperature. The apparatus disclosed by Sodeau was obviously adaptable to carry out this principle by a proper mechanical design to control the amount of fluid fed, and as a matter of fact the defendant's present torpedo complained of in this suit is an exact embodiment of the Sodeau inventions.

DEFENDANT'S TORPEDO DESCRIBED—AN EMBODIMENT OF THE SODEAU INVENTIONS.

It is found by the Court that the defendant's torpedoes which are now complained of are "practical duplicates" (Finding XIII, last paragraph, p. 22) of the experimental 21-foot by 21-inch torpedo originally built by the E. W. Bliss Company, which as early as September 24, 1911, before the contract at bar was proposed, the Government had on the testing range at Sag Harbor and which had made a run of over 9,500 yards. (Finding IX, last paragraph, p. 16.) The power plant of the Bliss torpedo shown in Exhibit III facing page 30 of the record is the apparatus of the Sodeau patent 6081 of 1907, published in April, 1908, long before Davison conceived of the device of his patent in suit. This structure of the prior art cannot be a part of any invention of Davison's and cannot be within the scope of his patent.

As your honors are aware from your consideration of the case of *E. W. Bliss Co.* v. *United States*, 253 U. S. 187, the E. W. Bliss Company had a working arrangement with Armstrong, Whitworth Company of England, the joint patentee of the Sodeau British patents and the assignee of the United States patents.

The contrast diagram will show the identity between the Sodeau disclosure and the Bliss or Government torpedo. The letters attached to the diagram of the Government torpedo are the same as those in the drawing forming a portion of Exhibit III but we have shown the two pipes H and J as if they were separate pipes throughout all their length whereas in the actual construction for convenience they are merged into a single pipe G in the portion nearest the reducing valve C. It is clear, however, that functionally there are two separate conduits, one leading to the water tank *P* and the other to the fuel tank *O* just as the Mt. Pleasant and Georgetown street car lines in Washington are separate lines and reach different destinations although they run over the same tracks as far as Dupont Circle.

In both the Sodeau disclosure and the Government torpedoes water and fuel are individually placed in separate compartments and these are provided with systems of piping whereby air is led from the low pressure side of the reducing valve separately to each one of these compartments and the discharge of liquids displaced by the air to the combustion chamber through separate pipes is provided for. To permit this displacement there is provided in each torpedo means for producing a differential in pressure so that water and fuel are fed into the combustion chamber. The Navy utilizes a perforated plate or restriction ring (Exhibit III, p. 32, Exhibits B-2, letter J, B-3

and B-4, Addition to Record), and also a Pitot effect.[1]" (Exhibit III, p. 32.)

Sodeau likewise provides for utilizing a Pitot effect and for reinforcing this Pitot effect by means of a perforated plate *j*. While the essential fact is simply that a differential in pressure is established and any known means could be utilized for effecting such change of pressure, as a matter of fact the Government utilizes what is described by Sodeau, the joint use of the Pitot phenomenon and the perforated plate or restriction ring. In the old outside superheater of the Sodeau United States patent, the idea was disclosed of feeding fuel by actually displacing the fuel from its containing vessel by some of the low-pressure air under a differential in pressure and in the Government torpedo now complained of an additional water tank is added from which water is fed in the same way as the fuel is fed. The Sodeau United States patent 835262 of 1906 (Exhibit C-7) showed fuel displaced by air under a differential in pressure produced by a restriction ring or perforated plate. Fig. 8 of the British patent 6081 of 1907 (Exhibit C-10) showed fuel fed under a differential produced by a Pitot tube, Fig. 2 showed fuel fed by the combined effect of a Pitot tube and a perforated plate and in Fig. 6 the patentee illustrated the feed

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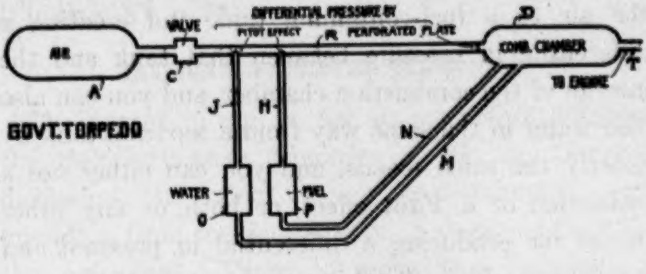
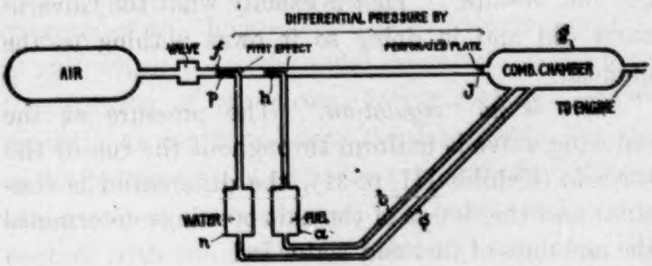
[1] The diagram gives merely a graphical indication that a Pitot effect exists and does not purport to represent pictorially the actual physical structure utilized. The Court below has found the existence of this Pitot effect in defendant's torpedo (Finding XIII, p. 21 and Exhibit III, p. 31) and the subject can be sufficiently understood by reference to the actual valve casting of the defendant's torpedo which is in evidence (Exhibit B-4). The valve in the casting is somewhat raised and it will be seen that the stream of air coming from beneath it is directed toward and into the opening where the branch pipe leads to the water and fuel tanks and that the column of air will rush into this pipe, creating a pressure due to its velocity.





SODEAU TORPEDO
FIG. 6 OF BR. PAT. 6091 OF 1907
WITH PERFORATED PLATE OR RESTRICTION RING AS IN FIG. 2 AND AIR FLASK DRAWN IN.

of water in conjunction with fuel in exactly the same way as in Fig. 3 by the use of a Pitot tube and described the conjoint use therewith of a restriction ring or perforated plate as illustrated in Fig. 2. The Sodeau disclosures state to those skilled in the art in substance, "You can feed fuel to the combustion chamber of a torpedo by admitting some of the air to a fuel-containing tank and creating a differential in pressure between that tank and the interior of the combustion chamber, and you can also feed water in the same way from a separate tank by exactly the same means, and you can either use a restriction or a Pitot effect, or both, or any other means for producing a differential in pressure and get your results." That is exactly what the Government did and in doing so it owes nothing to the plaintiff.

There is no "regulation." The pressure at the reducing valve is uniform throughout the run of the torpedo (Exhibit III, p. 31), the differential is constant and the design of the exit openings determines the amounts of fuel and water fed.

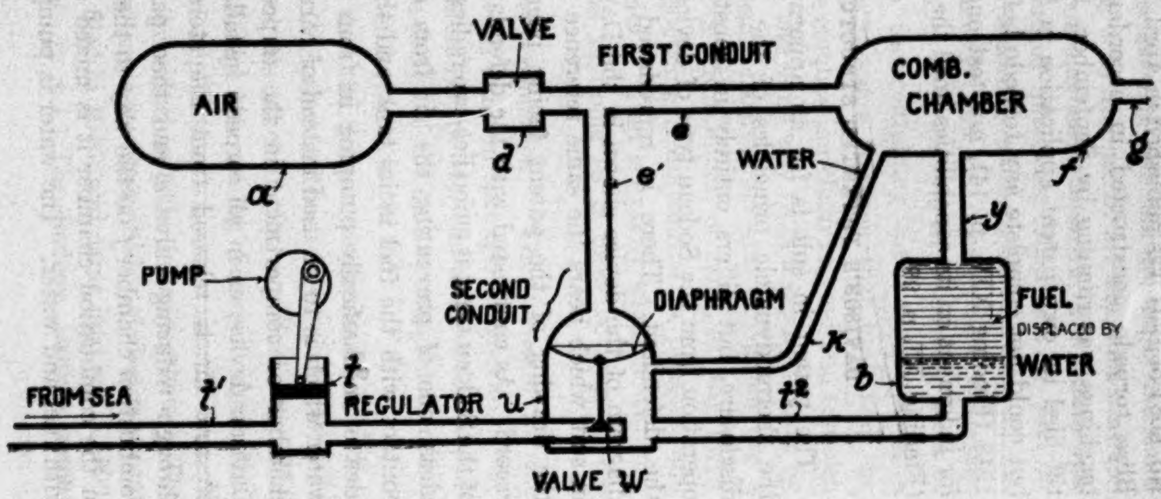
It is clear that the Sodeau disclosure as embodied by the Bliss Company in the Government's torpedo promptly took its place in the practical art. The time lag usually intervening between conception and practical application was even shorter than in the case of previous torpedo improvements. The outside superheater was described in Sodeau's patent No. 835262, filed in 1905, and came into use in 1909. (Finding IV, p. 9.) The Sodeau British patent

No. 6081 of 1907 was published in April, 1908, and the Bliss torpedo constructed in accordance with its teachings was running by September, 1911. Plaintiff filed its own patent application in March, 1909, but could not complete any torpedo before October, 1912 (Finding XIV, p. 14), nor test one sufficiently for judgment on its capabilities until the end of 1913 (Finding XI, p. 22).

DAVISON'S PATENTED STRUCTURE.

The patent in suit is for an apparatus utilizing the thermodynamic principles of the De Ferranti disclosure, but differs entirely in construction and operation from the Sodeau type of device utilized by the defendant. There is reproduced herewith a diagram of the device shown in the Davison patent in suit which bears the same reference numerals as the drawing of the patent facing page 25 of the record. As contrasted with the defendant's torpedo of the Sodeau type, it embodies two radically different ideas, one of preventing the air from coming into contact with the fuel in its tank and the other the idea of mechanically pumping in from the sea the water which is to be used instead of carrying it in a chamber or compartment in the torpedo. In the Davison device, as in all torpedo installations, high pressure air is released from the storage tank *a* through reducing valve *d* and then passes to the combustion chamber *f* on the way to the engine and in the combustion chamber it is mixed and burned with fuel and water. The water is pumped in from

PATENT IN SUIT



the sea by a pump *t* into the chamber of a regulating device *u* having a diaphragm subjected to the pressure of the low pressure air, which diaphragm controls a valve *w* leading from the pump. As contrasted with the Sodeau type of power plant the air never comes into contact either with the water or the fuel and does not displace or force them out from their containers. On the contrary it presses merely on the diaphragm of the regulator device and, if the pressure of the air in any way fluctuates, opens or closes the valve *w*, throttling the pump and controlling the amount of water which is delivered into the regulator chamber and consequently the amount which can pass through the pipe *k* to the combustion chamber. A portion of the water also passes through the pipe t^2 to the fuel container *b* and forces out the fuel. The entire structure and idea of the Davison patent is the *regulation* by the air pressure of the mechanically supplied water which, since the flow of fluid and water are interdependent, regulates the flow of both as a unit.

The Davison patent in suit is a development of the De Ferranti torpedo not only in its principle of using water, which it copies completely, but is a development and elaboration of the apparatus disclosed by De Ferranti. This will be particularly clear if we consider Mr. Davison's work preceding the filing of the application for the patent in suit.

Mr. Davison resigned from the Navy on Jan. 1, 1908, just after he had completed on behalf of the Government an extensive foreign trip to inspect

torpedo work abroad and he took with him the notes which he had made during that trip. (Finding III, p. 9.) Less than three months later, on March 19, 1908, he filed his application which resulted in patent 1,036,082, Exhibit C-15 (Finding XIV, p. 22. Addition to Record, p. 66). The apparatus of this patent bears a striking resemblance to the disclosure of the De Ferranti patent described above. See appellant's brief, pp. 68 and 84. It utilizes, just as is shown by De Ferranti, two pumps driven from the engine shaft, one for water and one for fuel (specification of the patent, p. 2, lines 103–106), the water pump taking its water from the sea (p. 2, lines 63–68), although it lacks the means of regulating the output of the pumps as described by De Ferranti (Addition to Record, p. 43). The patent in suit evidently represents an attempt to simplify and make more practical an apparatus of this character utilizing a pump.

In studying the specification of the patent in suit, we note that Davison never claims to have originated the idea of utilizing water in torpedo power plants. He states (record p. 25) that it would be a great advantage to utilize "a motive fluid derived by burning a suitable fluid with compressed air or oxygen and then injecting into the highly heated products of combustion a quantity of water whereby the water is converted into steam, adding to the volume of the fluid and increasing its temperature." He treats this as a well-known idea which it would be desirable

to utilize in practice "providing an apparatus can be devised which is of the requisite simplicity in construction and regulation so that it can be used without danger and with the assurance that it will be in operative condition whenever it is called upon to do its work." He then states definitely, "It is the object of the present invention to provide an apparatus suitable for that purpose," that is, his invention as he himself states is that of providing an apparatus for carrying out that purpose, and throughout the specification it is a fact which is emphasized that the essential points which he claims as novel and advantageous are *regulation* and *safety*, that is, in his own words again, an apparatus of "requisite simplicity in construction and regulation" and one which "may be used without danger."

The outstanding feature of Davison's design as contrasted with the earlier De Ferranti design is his "regulator" *u*, and through the claims he constantly speaks of the regulator which actually controls or regulates the amount of water which is supplied by the pump, governing it by the pressure of the low-pressure air. That is, the pressure of the low-pressure air is effective as a mathematical quantity. The air itself does not flow into liquid containing chambers as in the Government device to displace bodily the liquid therefrom but, because it is under pressure, it controls the diaphragm of the regulator chamber and controls the valve *w* which admits a greater or less amount of water from the pump. Such "regulation" is necessary

because the speed of the pump and its output may vary, although the air pressure remains constant and because it delivers an unsteady pulsating flow. De Ferranti provided for this by the by-passes described on page 43 of the Addition to Record. No means of controlling the pumps were present in Davison's earlier design. The one pump of the later design controlling the water in this manner also acts by displacing the fuel. That is, this single regulator controls the water and fuel supply as a unit as contrasted with the essentially independent systems in the Government torpedoes for displacing water and fuel separately, and because of this unitary control, which treats fuel supply and water supply as one, the air never comes into contact with the fuel and no explosive mixture can be formed in the fuel chamber *b*. This idea of the regulator, the thing which regulates or controls in accordance with the *numerical value of the pressure* of the air supply without bringing the air itself into contact with the fuel is emphasized again and again throughout the specification of the patent. Referring to the patent specification as reproduced in the record on page 27, we read as follows (italics ours):

> With this construction and arrangement of parts the *pressure* of the oxygen carrier in the pipe *e* on the low-pressure side of the reducing valve *d controls* absolutely the pressure on the fuel and the pressure on the water supply to the generating chamber, so that the oxygen

carrier, the fuel, and the water are fed always at a predetermined pressure to the generating chamber, and if, for any reason, the supply of oxygen carrier is cut off or exhausted, the supply of fuel and water to the generating chamber will cease at once, while, as long as there is a supply of oxygen carrier under pressure and the flow of water into the regulator chamber is not interrupted, the supply of fuel and water to the generating chamber will continue under proper control. Furthermore, by this arrangement *the fuel in the fuel tank,* as it is withdrawn, *is replaced by water,* which, of course, remains at the bottom of the tank. *This prevents a possibility of the admission of air or oxygen into the fuel tank and the formation therein of an explosive mixture. But a single pump is necessary to feed both the fuel and the water,* and it is made certain that the fuel and the water will be fed under the same pressure and will both be controlled by the pressure of the oxygen carrier. This *dependence of the fuel supply upon the water supply,* and their *mutual dependence upon the single pump* and the pressure of the oxygen carrier, is of further advantage in that *it is impossible that the water supply should be stopped and the fuel supply continued,* thereby creating unduly high temperatures in the generating chamber and engine. Furthermore, it will be observed, the arrangement is such, that *if, for any reason, such as the breaking down of the water pump, the flow of water into the regulator chamber is interrupted, the supply of fuel will immediately cease,* thus bringing the combustion to an end

> and preventing unduly high temperatures; but, nevertheless, the air or oxygen under pressure will continue to flow from the storage tank through the combustion chamber to the engine, and the torpedo will continue to be driven until the supply of oxygen carrier under pressure is exhausted.

Appellant has stated (brief, p. 32) that a primary feature of the Davison invention is that "the feed of the fuel and water is regulated in direct proportion to the rate of flow of air into the generator" and asserts the same (brief, p. 45) of the Government torpedo. *This assertion has no foundation in the record and we emphatically deny it.* In the Davison structure, where the water was pumped in by a mechanically driven pump independently of the air pressure and in a pulsating stream, regulation was necessary. The pump had to have a maximum discharge capacity at low speed and had to be throttled down to moderate capacity, especially after it had speeded up. The pulsations had to be smoothed out. No such necessity exists in the Government torpedo. The theory of this torpedo is not fully explained in the present record. To refute appellant's unwarranted statement, we must imitate it in going outside the record and assert that the differential in pressure which feeds the fuel and water does not vary directly with the pressure of the air, but in accordance with a complicated formula or function, and that the variation is of no practical importance. The record does show (Ex. III, p. 31) that the torpedo operates under

a uniform reducing-valve pressure. It follows that the differential is constant and that the rate of feed may be, and is, determined solely by the design of the exit openings into the combustion chamber (as described by Sodeau in his patent #835,262, Addition to Record following p. 47, folio 91, line 54), fixed once for all, and does not vary appreciably throughout the run of the torpedo. The finding of the court below of noninfringement as a fact includes the determination of this question.

DAVISON'S POSITION IN THE PRACTICAL ART.

Is there any reason why Davison's patent should be considered as more than what it appears to be on its face, a patent covering a detailed development of a specific form of apparatus entirely different from the form of apparatus utilized by the defendant? Was Davison in any way a pioneer in the practical development of the principles of water injection and did he teach the art how to apply practically the theoretical principles long previously disclosed by De Ferranti? The answer is emphatically "no." The apparatus designed by Davison was a practical failure and had no effect on the art at all. On July 26, 1910, when Commander Norton, the torpedo officer at the Bureau of Ordnance, visited the plaintiff's plant, the work was abandoned or suspended and he had to urge Davison to take it up *again*. (Finding VI, p. 11.) The first torpedo built by the plaintiff was not completed until October, 1912, and it was a failure and could not run as far as the old outside superheaters previously known. (Finding VIII, last

paragraph.) The converted Whitehead torpedoes were not completed until November, 1912, and these too were a practical failure. Long before this, as early as September 24, 1911, the Bliss torpedo, a "practical duplicate" of those complained of in this suit (Finding XIII, 3rd paragraph, p. 22) was at the Government testing range at Sag Harbor and had run substantially 10,000 yards. (Finding IX, last paragraph, p. 16.) In January, 1912, the Government was preparing contracts to purchase large numbers of these torpedoes. (Finding VIII, 3rd paragraph, p. 14.) It was more than a year after the successful demonstration of the Bliss torpedo before the plaintiff produced any torpedo. The experimental torpedo never came up to the minimum requirements. The converted Whiteheads were experimented with and experimented with until finally one on a single occasion limped across the 6,000-yard finish line. On September 27, 1913, the torpedo board considered what plaintiff had done and found: "The reliability of this form of steam generator has not been established * * *. There are grave doubts as to the practicability of this device as at present fitted for service use." (Finding XI, p. 21.) The demonstration is a demonstration of failure, not a demonstration of success. It is true that the Navy paid the pittance of $3,000 for the work that had been done on the Whiteheads. But, if this charitable act be considered as a proof that the Davison steam generator was successful, it will nevertheless be seen that that

demonstration waited until long after the Bliss Company's torpedoes had become standard in the Navy.

The practical art owes nothing to Davison or the plaintiff, nor was the Bliss Company's success in any way based on what Mr. Davison had done. The plaintiff on p. 87 of his brief does not scruple to insinuate that Commander Norton violated professional confidence by disclosing to the Bliss Company principles which he had acquired from the Electric Boat Company. If the evidence below had not been to the contrary, the court would not have failed to find so important a fact. The charge is refuted by the facts of record. In 1908, when their attention was called to the article in the Brazilian publication, the Bliss Company stated that they had plans along the same line (Finding V, 2nd paragraph, p. 10) and in view of their close relation with Armstrong, Whitworth & Company, of which this court is aware, which concern owned the Sodeau patents, who can doubt what the plans were? However, the only time when Commander Norton could have acquired any knowledge from Davison was on July 26, 1910, when he visited the Electric Boat plant, but there was little to be learned from Mr. Davison at that time and he was not shown any physical devices. (Finding VI, p. 11.) Already in 1910 the Bureau of Ordnance had been receiving verbal information from the Bliss Company with reference to their experiments along the same line and the written records show that by October 14, 1910, the Bliss Company informed the Bureau of past experiments which indicated definitely

a doubling of horsepower obtainable from a flask full of air by means of water injection (Finding V, last two paragraphs, p. 11) and with great promptitude it built a practical torpedo on the basis of these disclosures. Could any oral information which Commander Norton could have gained at the Electric Boat Company's plant at the end of July have enabled the Bliss Company to construct an apparatus and complete a series of experiments by the first of October? Novel devices in torpedoes are not built overnight even by skilled workmen. The prompt production of a successfully operating torpedo by the Bliss Company indicates clearly that the principles were by no means new to that company. The radical difference between the form of apparatus used by the Bliss Company and that utilized by Davison demonstrates the entire independence of the Bliss Company's work. It was not the hurried result of pirated information obtained from the plaintiff who for all its alleged advantage as an originator in the art could not produce any torpedo at all until more than a year after the Bliss Company had succeeded and then produced one not fit for adoption and use.

That Davison was an original and hard-working inventor we do not attempt to deny. That the Electric Boat Company expended time and effort on the development of torpedoes, we do not attempt to deny. That they ever produced a practical torpedo we do deny and the record bears us out. De Ferranti published to the world the theory of the water torpedo. Sodeau had shown an apparatus

which could be utilized for carrying out the theory and the E. W. Bliss Company successfully embodied the Sodeau apparatus in actual metal in a torpedo, and this torpedo was performing as a torpedo operates in war time and in the open ocean before the Electric Boat Company and Mr. Davison had either completed a torpedo or placed one in the water.

THE SCOPE OF THE PATENT IN SUIT.

The Law of License Construction.

In any contract such as the present, wherein one party contracts to pay for the use of a certain thing, it must be shown that he has used it if he is to be held liable under his contract. In the present instance the defendant contends that what it contracted for was a specific thing, the "Steam Generator for Automobile Torpedoes," the device which was to be installed in the converted Whiteheads, and that this it has not used (supra, p. 62). It also contends that it can not be bound by the tenor of patent claims not in existence when the contract was executed and not considered by the parties. There could be no meeting of the minds of the parties on a definition not present in their minds (supra, p. 83). However, the defendant is further prepared to show that what it makes is not within the terms of the patent claims and that it is not bound, even if the contract in suit is considered as if it were an ordinary patent license entered into after the patent was granted and binding the defendant to pay for "the patented improvements."

In considering the contract from this view we should consider what rules control its construction. It is admitted that a licensee under a patent, at least in the ordinary case where he receives his license after the patent is granted and knows its tenor, can not, when sued for royalties, deny the validity of the patent. Does the estoppel extend any further? It will be convenient before discussing the adjudicated cases in detail to state the conclusion drawn from them by Walker in his standard work on patents. The references are to the fifth edition.

> Estoppel by matter of deed may also arise in patent affairs. Where, for example, the alleged infringer has by contract admitted the validity of the patent and agreed not to infringe in the future, or where an assignor or grantor of a patent right, afterwards infringes the right which he conveyed, he is estopped by his conveyance from denying the plaintiff's title, or the validity of the patent, when sued for its infringement. (Section 469, p. 546.)
>
> But such an assignor or grantor is not estopped, by his conveyance, from showing how narrowly the patent must be construed, except to the extent to which he may have made representations as to the scope of the patent as an inducement to the sale. He may not, however, introduce evidence ostensibly for that purpose, but which in fact tends to show that the patent is invalid. (Section 469, p. 548.)

And again Walker states:

> As long as a licensee continues to enjoy the benefit of the exclusive right, he must pay the

royalty which he promised to pay, and he can not escape from so doing by offering to prove the patent to be void. (Section 307, p. 366.)

Wherever the licensor sues for the promised royalties, the defendant may introduce evidence of the prior art, to guide the court to the construction of the patent, and thus to aid in the ascertainment of the extent of those doings of the licensee which are subject to the payment of royalties. (Citing *Andrews* v. *Landers*, 72 Fed. 666; Section 309, p. 372.)

We have quoted from Walker both the rules which apply to an assignor of a patent who is sued thereafter for infringement by his assignee and those applying to a licensee who is sued for collection of royalties, as the legal situation of each is the same, and because the two cases have been treated as interchangeable by the courts, who cite either instance as a precedent for the decision in the other. This is amply clear, for example, from the decisions of the Circuit Court of Appeals in the Seventh Circuit, which in *Chicago & Alton Ry. Co.* v. *Pressed Steel Car Co.*, 243 Fed. 883, applied a rule of estoppel to a licensee on the authority of *Siemens-Halske Electric Co.* v. *Duncan Electric Mfg. Co.*, 142 Fed. 157, a case of an assignor. The Court of Appeals in the Second Circuit in *Pressed Steel Car Co.* v. *Union Pacific Ry. Co.*, 270 Fed. 518, in deciding a case involving a licensee, cited as precedents, without distinguishing among them, cases involving licensees, assignors, and defendants who had specifically covenanted to respect the validity of a patent. In the First Circuit in *Babcock*

v. *Clarkson*, 63 Fed. 607, the case of an assignor, the rule announced in the case of a licensee by the same Court in *Ball & Socket Fastener Co.* v. *Ball Glove Fastening Co.*, 58 Fed. 818, is quoted and adopted, and in a subsequent case involving an assignor, *Martin* v. *Hill Cash Carrier Co.*, 67 Fed. 786, both these cases are referred to without distinction as authority for the case of an assignor.

In the case at bar any disability under which the defendant may be must arise solely from the mere relation of licensor and licensee. There are no special circumstances which could give rise to any further estoppel. The Government does not deny the validity of the plaintiff's patent. It is content to admit that validity, merely stating that what it makes is an embodiment of the constructions of the prior art not comprehended within the scope thereof. The class of cases illustrated particularly by *Alvin* v. *Scharling*, 100 Fed. 87, holding that an assignor can not have a patent declared invalid by calling his contention to that end by another name and stating that he wishes to limit the scope of the patent is also to be distinguished. No such case arises here as the Government's contentions may be fully sustained and the patent will remain valid and of considerable scope covering the mechanisms disclosed and particularly pointed out by the specification as advantageous. Further to be distinguished is the line of cases illustrated by *United Printing Machinery Co.* v. *Cross*, 227 Fed. 600 (1915), C. C. A. First Circuit. There was a true estoppel *in pais*. In that case the assignor

when selling the patent made representations as to its scope which he could not thereafter be heard to deny. There is no such estoppel in the present instance. A still further class of cases is illustrated by *Pope* v. *Owsley*, 27 Fed. 100, C. C. N. D. Illinois (1886). In this case the parties by their past dealings under the license had interpreted the patent for themselves and having considered that certain constructions were within the terms of the patent were precluded thereafter from contending for a more restricted construction. This also differs from the case at bar wherein the Government has consistently and from the beginning denied that the contract has any relation to the structure which it makes. Between the plaintiff and the defendant in this case there is no relation except at most the bare relation of licensor and licensee. In fact the relation differs markedly from the usual one where the license is entered into on the basis of a patent already granted and known to both parties, since the patent in suit was not issued at the time the contract at bar was executed and the terms of the patent claims were entirely unknown to the Government at that time.

Admitting that a licensee or an assignor cannot set up the invalidity of the patent, it would seem obvious that the conclusions stated by Walker are correct and that unless bound in equity and in good conscience by his own acts to an actual estoppel *in pais*, he can offer any pertinent evidence including the state of the prior art to show what the patent actually is and what is its scope in order to show

that his acts which are complained of are not within the scope of the license. We submit that this is the true rule which is adhered to by seven of the eight Circuit Courts of Appeals which have passed on the question, and which is furthermore supported by statements of this Court. As the Courts in the Seventh Circuit, however, apply a peculiar rule of their own, repudiated by the Courts in the other Circuits, it is proper here to examine the cases in some detail.

The leading case on the subject was decided in 1900 by the Circuit Court of Appeals in the Sixth Circuit in *Noonan* v. *Chester Park Athletic Ass'n*, 99 Fed. 90. Judge Lurton, afterwards Mr. Justice Lurton of this Court, delivered the opinion which was concurred in by Judge Taft and Judge Day. The Court said (page 91):

> It seems to be well settled that the assignor of a patent is estopped from saying his patent is void for want of novelty or utility, or because anticipated by prior inventions. But this estoppel, for manifest reasons, does not prevent him from denying infringement. To determine such an issue, it is admissible to show the state of the art involved, that the court may see what the thing was which was assigned, and thus determine the primary or secondary character of the patent assigned, and the extent to which the doctrine of equivalents may be invoked against an infringer. The court will not assume against an assignor, and in favor of his assignee, anything more than that the invention presented a sufficient degree of utility and novelty to justify the issu-

> ance of the patent assigned, and will apply to the patent the same rule of construction, with this limitation, which would be applicable between the patentee and a stranger.

As we will later point out, this case has been consistently followed by the Courts of the Sixth Circuit and by all other Courts except that in the Seventh Circuit. In the Seventh Circuit in *Siemens-Halske Electric Co.* v. *Duncan Electric Mfg. Co.* (1905), 142 Fed. 157, a case involving a suit against an assignor, the Circuit Court of Appeals held that "between contracting parties extraneous evidence is inadmissible if there is no ambiguity or uncertainty in the language of the description and claims, and that, if there is uncertainty, outside evidence is admissible only to make clear what the applicant meant to claim and the Government to allow, and not for the purpose of showing, even in the slightest degree, that the applicant had no right to claim and that the Government was improvident in allowing what was in fact claimed and allowed."

On the authority of this case the same Court later extended this rule to the case of a licensee in *Chicago & Alton Ry. Co.* v. *Pressed Steel Car Co.* (1917), 243 Fed. 883.

The doctrine announced in the *Siemens-Halske case* was entirely novel. It ignored the directly contrary holding in the Northern District of Illinois in the same Circuit by Judge Seaman in *Western Telephone Construction Co.* v. *Stromberg* (1895), 66 Fed. 550. It finds no support in the authorities cited by

the Court. Of the United States cases referred to practically all sustain merely the admitted proposition that an assignor cannot deny validity. The *Harvey Steel* case, which is cited, is clearly not applicable as the discussion thereof in this brief has shown and is specifically distinguished from this class of case by the Court of Appeals for the Second Circuit in *Pressed Steel Car Co.* v. *Union Pacific Ry. Co.*, 270 Fed. 518 at 524. The holding of the Court apparently finds some support in the *language* of *Pope* v. *Owsley*, 27 Fed. 100, but this was a case wherein the scope of the patents had been defined by the parties for themselves by their past dealings and the holding of the Court went no further than to preclude the defendant from taking a position inconsistent with his past actions. The decision of the Circuit Court of Appeals for the First Circuit in *Babcock* v. *Clarkson*, 63 Fed. 607, which is relied upon, is in fact authority for the directly opposite proposition as will be clear from the decision of the Circuit Court below, affirmed by the Court of Appeals, which decision is reported in 58 Fed. 581, the lower Court construing the patented claims in view of no less than fourteen prior patents.

We will not attempt to analyze the English cases cited except to point out that they are clearly inapplicable because in the United States an individual is charged with knowledge of the contents of all prior patents and publications (*Derby* v. *Thompson*, 146 U. S. 476 at 481; *Mast Foos Co.* v. *Stover*, 177 U. S. 485, at 494), whereas in English law a distinction is

drawn between "mere public knowledge," which must be brought home to an individual by actual proof, and matters of "common general knowledge" with which the individual is charged and which must be proved by the evidence of witnesses cognizant of the state of knowledge or by reference to generally accepted and widely read text books or the like. See Fletcher Moulton on Patents, page 57. Under the English law the specifications of prior patents are not competent evidence of "common general knowledge" (*Mackie* v. *Solvo*, 10 R. P. C. 68 at 70; *Saccharin Corporation, Ltd.*, v. *Chemical & Drugs Company, Ltd.*, 17 R. P. C. 28).

Appellant cites but three cases as in harmony with those of the Seventh Circuit. (Brief p. 55.) Two are directly contrary; the third has no application. In *Leader Plow Company* v. *Bridgewater Plow Company*, 237 F. 376, the court, after specifically approving the rule of the *Noonan case* (p. 377), said (p. 378):

> With these principles in view the first inquiry is as to the difference between the patents acquired by the plaintiff and the prior art.

In *United States Frumentum Company* v. *Lauhoff*, 216 Fed. 611, no prior art was before the court (statement of facts p. 612), but the court (p. 613) quoted the rule of the *Noonan case* as the law. The third case, *United Printing Machinery Company* v. *Cross*, 227 Fed. 600, involved, as we have already pointed out, an actual estoppel *in pais*.

Subsequently to the Siemens-Halske case the Circuit Court of Appeals for the Sixth Circuit again considered the question and speaking again through Judge Lurton with whom sat Judges Severens and Warrington, in *Babcock & Wilcox Co.* v. *Toledo Boiler Works* (1909), 170 Fed. 81, reiterated their previous decision stating (page 84):

> The estoppel is one limited in character, and such an assignor, when subsequently sued for infringing the assigned patent, may show the state of the art for the purpose of limiting its scope.

The conflict of authority was discussed exhaustively by Judge Rose, now Circuit Judge, in *Automatic Switch Co.* v. *Monitor Mfg. Co.*, 180 Fed. 983, a case arising in 1910 in the Circuit Court for Maryland. He emphasized the high authority of the judges in the Sixth Circuit who decided *Noonan* v. *Chester Park Athletic Association* and after discussing the *Siemens-Halske case* pointed out that after the decision thereof the Court in the Sixth Circuit in the *Babcock & Wilcox case* had adhered to its former ruling which was in harmony with the decisions of the Court of Appeals in the First Circuit. At this time the Court of Appeals in the Fourth Circuit had not as yet passed upon the question. Judge Rose repudiated the authority of the *Siemens-Halske case* and said in part (the quotation is from page 992):

> There is nothing mysterious about the doctrine of estoppel. A man is estopped be-

cause in equity and good conscience he should not be allowed to say something, although that something may be true. Whether equity and good conscience require that he shall keep his mouth closed may and usually does in large part depend upon the special facts and circumstances. One who knew well the state of the art might sell a patent to one who knew nothing about it. In order to make the sale, he might read the claims to the buyer. He might comment on the breadth of their language. He might assert that he knew that they covered every possible machine by which the wished for result could be attained. Such a seller, I take it, when sued for the infringement of a patent he had sold, would not be permitted to set up the prior art for the purpose of showing that the patent was in fact a very narrow one; that it covered a limited class of machines only and that there were large classes of machines not covered by the patent which would accomplish substantially the same results. The circumstances under which a patent may be assigned may be quite different. An inventor may be in the employ of another. He may turn over his inventions to his employer, the employer may at his own expense prosecute applications for patents for such of these inventions as it may think valuable. When such employe subsequently changes his employment, there seems to be no reason why he should be any more estopped than any one else from showing that the patent he assigned, though valid, must be narrowly construed.

And Judge Rose concludes:

> In any event, claim 8 must be construed as limited by the prior state of the art. So limited, it appears to me that the difference between the construction described in the patent and the devices made by the defendants are so substantial as to exempt the latter from the charge of infringement.

The *Siemens-Halske case* was also specifically discussed by Judge Thompson in the Eastern District of Pennsylvania in a case likewise arising before the Circuit Court of Appeals of that Circuit had passed upon the question, *Rollman Mfg. Co.* v. *Universal Hardware Works*, 207 Fed. 97. Judge Thompson likewise repudiated the *Siemens-Halske case*, stating on page 102:

> If the *Siemens-Halske case* is to be construed as denying the right to introduce evidence of the prior art except to explain ambiguity or uncertainty in the claims, the weight of authority is undoubtedly in favor of the rule laid down by Mr. Justice Lurton in the case of *Noonan* v. *Chester Park Co.*

Neither of the District Court decisions which we have just referred to was appealed, but, as the citations which we will subsequently give will show, the Circuit Courts of Appeals in both the Fourth and Third Circuits in later decisions approved of the holdings in these cases and announced views in harmony with the Noonan case rather than the Siemens-Halske case.

We do not find that the Supreme Court of the United States has definitely and unequivocally passed upon this question. However, in the case of *Thorn Wire Co.* v. *Washburn & Moen Co.* (1895), 159 U. S. 423 at 449, Justice Shiras, speaking for the Court, said:

> If the issue thus raised under the pleadings presented the question whether the Washburn and Moen Company should account for royalty received by it from the sale of Brinkerhoff barb fencing, because such fencing was an infringement of the Kelly patents and thus within the terms of the contract, it would be necessary for us to investigate the state of the art at the time the patents were granted as well as to compare the several claims of the respective patents, and our inspection of this record has not disclosed to us the materials necessary to enable us to do this intelligently.

More recently this present Court in the case of *Foley* v. *United States,* (1921) 260 U. S. 667, rendered a decision which does not lend itself to an exact quotation but which, after affirming the Court of Claims in holding that no contract existed, followed and approved the Court of Claims in its review of the claims of the patents in the light of the prior art, concluding that in view of that art the claims must be limited so that what the defendant, the Government, did was not within the scope of the patents (pp. 676–677).

The rule of *Noonan* v. *Chester Park Athletic Ass'n* has been definitely stated by the Circuit Courts of Appeals in the first, second, third, fourth, sixth,

eighth, and ninth circuits. No cases have arisen in the fifth circuit. We refer to some of the leading cases.

First Circuit.—The rule was applied by the Circuit Court of Appeals in the First Circuit in the case of a license in *Wright* v. *Fitz Bros.* (1904), 133 Fed. 394, Judge Aldrich, with whom sat Judge Putnam and Judge Brown, announcing the opinion of the Court, which concluded:

> In view of this earlier patent, the substantial novelty of the two vertical holes in the Clark last is not in the holding function but in the function of spreading and lengthening. It results, therefore, that the Amos G. Fitz last does not violate the rights of the complainants under the license.

The rule in the case of an assignor is stated and applied in *Martin* v. *Hill Cash Carrier Co.* (1895), 67 Fed. 786. It is stated for a licensee in *Ball & Socket Fastener Co.* v. *Ball Glove Fastening Co.* (1893), 58 Fed. 818 at 820, 823, that case, however, being a peculiar one, in which a severe burden was placed upon the defendant since he occupied a truly fiduciary relation toward the plaintiff. As we have already pointed out, the more recent decision in this Circuit in *United Printing Machinery Co.* v. *Cross* (1915), 227 Fed. 600, involves an actual case of estoppel *in pais*, as the assignor in this case when he assigned the patent made representations as to its scope.

Second Circuit.—The rule in the Second Circuit was probably first stated by Judge Townsend in

Andrews v. *Landers* (1896), 72 Fed. 666, a case arising in the Circuit Court for Connecticut. Judge Townsend's opinion concludes (page 671):

> As to the evidence offered to show the prior state of the art, I rule that the same is admissible, not to invalidate the Andrews patent but to explain the latent ambiguity in the language, "containing the patented improvement," and as bearing upon the situation of the parties and their object in making said contract.

Judge Townsend, then Circuit Judge, sitting with Judges Lacombe and Wallace, afterwards delivered the opinion of the Court of Appeals for the Second Circuit in *Western Electric Co.* v. *Robertson* (1905), 142 Fed. 471, a case of a suit against a licensee for the recovery of royalties. The Court considered in detail a prior patent to one Eaton and concluded its opinion as follows:

> In interpreting the Robertson patent, we must read into it the limitations imposed by the disclosures of Eaton. A comparison of defendant's structure with that of Eaton shows that defendant has merely taken the Eaton structure with the wing or portion of a wall above the core tube and improved upon it.
>
> We are of the opinion, therefore, that the construction of the patent in suit is determined, as a matter of law, by the limitations of the prior art, and that when thus interpreted its scope can not be extended to embrace the defendant's structure.

The rule has been consistently applied by the Circuit Court of Appeals from that time on, and the most recent decision stating it for the case of a licensee was rendered in 1920, *Pressed Steel Car Co.* v. *Union Pacific Ry. Co.*, 270 Fed. 518, numerous authorities in the Second Circuit and elsewhere being cited on pages 524 and 525.

Third Circuit.—Subsequently to the decision of Judge Thompson in *Rollman Mfg. Co.* v. *Universal Hardware Works* referred to above, the question came before the Circuit Court of Appeals in the Third Circuit in 1922 in *Piano Motors Corp.* v. *Motor Players Corp.*, 282 Fed. 435, a case of an assignor, this decision being in harmony with the Noonan case and contrary to the Siemens-Halske case.

Fourth Circuit.—In the Fourth Circuit also, subsequently to Judge Rose's decision above referred to, the Circuit Court of Appeals announced the rule in *Leader Plow Co.* v. *Bridgewater Plow Co.* (1916), 237 Fed. 376, a case of an assignor. The Siemens-Halske case is cited in the opinion but is not followed. On the contrary the rule of the Noonan case is upheld.

Fifth Circuit.—No cases appear to have arisen in the Fifth Circuit.

Sixth Circuit.—We have already pointed out that after the Siemens-Halske case the Circuit Court of Appeals in *Babcock & Wilcox Co.* v. *Toledo Boiler Works*, 170 Fed. 81, reiterated the doctrine of the Noonan case, and this rule has been consistently followed in the Sixth Circuit, the latest decision being

in 1914 in *Schiebel Toy & Novelty Co.* v. *Clark*, 217 Fed. 760.

Eighth Circuit.—Moon-Hopkins Co. v. *Dalton Adding Machine Co.* (1916), 236 Fed. 936, a case of an assignor, agrees with the majority rule as announced in the Noonan case.

Ninth Circuit.—Leather Grille & Drapery Co. v. *Christopherson* (1910), 182 Fed. 817, another case of an assignor, while citing the Siemens-Halske case, follows the majority rule of the Noonan case.

The Supreme Court of Massachusetts also lends its authority to the majority rule, Judge Hammond rendering the opinion of the Court in 1906 in *Aberthaw Construction Co.* v. *Ransome*, 192 Mass. 434.

It will be seen that, in addition to the Supreme Court's expressed attitude on the subject, the question has been specifically considered by eight of the nine Circuit Courts of Appeals, that seven definitely hold that the prior art is pertinent and admissible and that six of these seven Courts have specifically considered the question subsequent to the Siemens-Halske case, and decided contrary to that case, in the Second Circuit as recently as 1920, in the Third Circuit in 1922, in the Fourth Circuit in 1916, in the Sixth Circuit in 1909 and in other cases up to 1914, in the Eighth Circuit in 1916, and in the Ninth Circuit in 1910. The overwhelming authority is in favor of the rule that a licensee, while estopped to deny validity of the licensor's claim to the subject of the license, is always permitted to define that subject by reference to the prior art, except where by reason

of the circumstances of the case a special estoppel is created. In the present case the findings negative the existence of any circumstances which might modify the rule.

It is believed, furthermore, that the case at bar comes even within the strict rule of the Seventh Circuit, but it is submitted that the rule of the Seventh Circuit should really not be considered a rule, and finds no true application except perhaps in certain cases readily accounted for by their specific facts. It is questionable whether any patent can be adequately understood without reference to the prior art. A patent has no existence and has no meaning except in the setting of that prior art, and it is questionable whether any judicial tribunal can have an adequate or proper understanding of a patent document unless it accepts all possible aids afforded by a study of the art.

It is conceivable that a patent claim might be so perspicuous in its language and so absolutely definite that if it existed at the time of the contract and was present in the minds of the parties, it would be impossible to say that either party could have understood it in any but one way, and that way the Court would enforce. That is not the case at bar, where the claims are as vague and involved as any patent claims could be. It is not the case at bar, because the claims were not known to the parties when they wrote the contract.

It is also possible that in a given instance the physical structures of the plaintiff and the defendant may be such practical duplicates that to talk of the terms

of the claims is unnecessary. The structures may speak for themselves and show that the defendant's structure is the patented structure. That was the fact in the *Chicago & Alton* case above referred to. It is not the case at bar, where the structures are entirely different on their face.

It is respectfully submitted that a plaintiff can never say, "Here is the claim of my patent, and I interpret it to mean so and so and understanding it in this way, read it upon the defendant's structure, and the Court must accede to this interpretation, and can not look beyond it to determine whether it is correct." We do not believe that the Court of Appeals of the Seventh Circuit wished to emulate the learned Justice of the Peace who stopped defendant's counsel, and said that he did not wish to hear the other side of the case because "it confused the Court."

In the next division of this brief we shall analyze the claims on which plaintiff relies in the light of his specification and show that the reasonable interpretation of them does not cover anything that plaintiff does. In the light of the rule of the overwhelming majority of Circuit Courts of Appeals, and the rule which this Court, in *Thorn Wire Co.* v. *Washburn & Moen Co.* 159 U. S. 423 at 449, said it would be necessary to follow if the question were before it, such an interpretation and evaluation of the scope of plaintiff's claims is absolutely obligatory because any broadening of their scope to include the defendant's structure broadens them to include the Sodeau disclosures of the prior art anterior to Davison's invention.

The terms of the patent claims do not include defendant's device.

From general considerations it is clear that since the Sodeau British patent was a printed publication and a part of the prior art before any conception by Davison of the device shown in his patent, and since the Government torpedo as built by the E. W. Bliss Company is the device of the Sodeau patent, the possible extent of the novel invention which could be secured to Davison by a patent under our laws did not include the present Government torpedo. Apart from this, however, if the specification and claims of the patent in suit are carefully but fairly read, it clearly appears that the invention set forth in the patent and covered by the claims has for its essence the use of a single *regulated* pump acting on both water and fuel as a unit in place of the two separate unregulated pumps of De Ferranti or of Davison's patent 1,036,082 based on his earlier application and the idea of using the *pressure* of the air to regulate or control the feed of the water and fuel by the pump instead of utilizing the air as a displacing fluid. These ideas are emphasized by the words of the claims and in fact the words of these claims cannot be applied literally to the Government's torpedo.

If we examine the patent in suit as reproduced beginning on page 25 of the record, we find that the patentee after referring to the advantages of the use of water, which advantages were well understood in the art, states that "it is the object of the present invention to provide an apparatus" and an

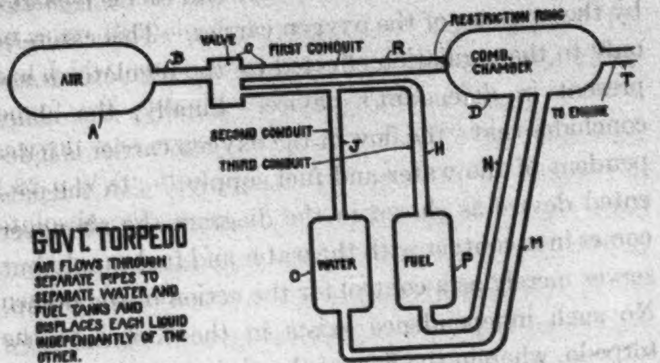
apparatus "of the requisite simplicity in construction and *regulation*" and one which "may be used without danger." Without any further characterization of the apparatus the specification then proceeds to a detailed description of the drawings and after this has been completed it continues on page 27 of the record to point out the characteristics of the device which has been described. We find the following statements (italics ours):

> But a *single pump* is necessary to feed both the fuel and the water and it is made certain that the fuel and the water will be fed under the same pressure and will both be controlled by the pressure of the oxygen carrier. This *dependence of the fuel supply upon the water supply*, and *their mutual dependence upon the single pump* and the pressure of the oxygen carrier, is of further advantage in that *it is impossible that the water supply should be stopped and the fuel supply continued*, thereby creating unduly high temperatures in the generating chamber and engine.
>
> If, for any reason, such as the breaking down of the water pump, the flow of water into the regulator chamber is interrupted, the supply of fuel will immediately cease.
>
> This (the construction) *prevents a possibility of the admission of air* or oxygen *into the fuel tank* and the formation therein of an explosive mixture.
>
> With this construction and arrangement of parts the *pressure* of the oxygen carrier in the pipe *e* on the low pressure side of the reducing valve *d controls* absolutely the pressure on

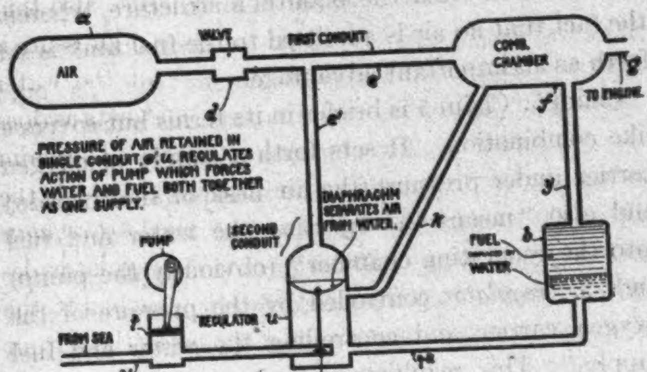
the fuel and the pressure on the water supply to the generating chamber.

This characterization of the essence of the patent is carried over into the claims. The plaintiff relies on Claims 1, 5, and 13, and the Court of Claims, which had the advantage of the fuller record below, has found that the Government does not utilize any devices within the terms of these claims. (Finding XV, p. 22.) A careful reading of these claims shows the absolute correctness of the Court's finding.

Claim 1. This claim calls for a tank for an oxygen carrier under pressure (the ordinary air flask of the torpedo) and "an auxiliary source of pressure for the water and fuel supply." This latter is obviously the pump and in the defendant's torpedo there is but one source of pressure, the air flask. We notice also that the claim says that this auxiliary source of pressure is "for the water and fuel *supply*," not for the water and fuel *supplies* in the plural; that is, it acts as does the pump on both water and fuel as a unit. The claim then calls for "a second conduit through which the *pressure* of the oxygen carrier is applied to *regulate* the pressure of the fuel." This is the regulator device *u* which by means of the valve *w* attached to the diaphragm actually controls and regulates the output of the pump in accordance with the pressure, quantitatively considered, of the air. In the defendant's torpedo the air is under pressure but its pressure as such is not a factor. The air enters as a displacing fluid, comes in contact with the water and fuel and crowds them out of the containing tanks. It operates



PATENT IN SUIT



on each separately and the supply of water might fail while the supply of fuel might continue. The claim then states that the flow of water and fuel is *regulated* by the pressure of the oxygen carrier. This can refer only to the regulation effected by the regulator *u* not present in defendant's device. Finally, the claim concludes that "the flow of the oxygen carrier is independent of the water and fuel supply." In the patented device as shown in the diagram the air never comes into contact with the water and fuel supply but serves merely as a control for the action of the pump. No such independence exists in the Government's torpedo, wherein the flow of the air into the water and fuel containing tanks causes the supply of these fluids, and the air comes directly in contact with the fuel as distinguished from the plaintiff's structure, wherein the fact that no air is admitted to the fuel tank is set forth as an important advantage.

Claim 5. Claim 5 is briefer in its terms but covers a like combination. It sets forth a supply of oxygen carrier under pressure (the air flask of the torpedo) and also "means for injecting the water and fuel into the generating chamber" (obviously the pump) and a "*regulator* controlled by the pressure of the oxygen carrier and controlling the water and fuel supply." This regulator is obviously the device *u*, so called throughout the specification of the patent and not present in the defendant's torpedo. In the defendant's torpedo there are no separate means for injecting the water and fuel, but the low-pressure air

flows to the combustion chamber and to the fuel-containing tanks without any regulation or control. The essence of this claim is obviously the provision of such means as a pump, the "single pump" referred to in the specification, and the regulator which controls or governs the action of this pump.

Claim 13. Claim 13 likewise covers the regulator which is the characteristic feature of the patent in suit. This is expressed by the language "a second conduit likewise controlled by the valve (that is, it is on the outlet side of the main reducing valve of the torpedo) and through which the *pressure* of the oxygen carrier is applied to the fuel and water *supply* * * * whereby the water and fuel feed to the generator depends at all times upon the *pressure* of the oxygen-carrier." The conduit referred to is obviously the control or regulator device *u* and its connecting pipe *e'*, not merely a piece of pipe as that would leave the claim fatally incomplete and unintelligible. It is "*a* second conduit," that is, one device, and it applies "the pressure" of the air to "the water and fuel *supply;*" that is, to the water and fuel supply as a unit. The water is pumped in from the ocean and displaces the fuel before it. The regulator device by means of the valve *w* opens or closes the outlet from the pump which supplies the water in accordance with the value of the pressure of the air and in so doing it controls as one unit the supply of water and fuel and thus this supply will at all times depend on and be governed by "the *pressure* of the oxygen carrier."

No such structure is present in the Government torpedo. There is no device which corresponds to the regulator of the patent and which governs as a unit the feed of water and fuel in accordance with the pressure of the air. The air passing from the main reducing valve flows into the water and fuel tanks and displaces the liquids therefrom. There is a water supply and a fuel supply. There is nothing which corresponds to the "second conduit" of the claim. Even if we understood "conduit" to mean no more than a pipe, the claim does not read upon the Government torpedo. In the Government torpedo there is a *second* pipe or conduit leading to the water tank, viz, a passage through the pipes G and J, and a *third* pipe or conduit leading to the fuel tank, viz, a passage through the pipes G and H, and while these passages are merged together for a portion of their length in the pipe G they are functionally entirely separate passages and through one, G, J, the air is admitted to the water tank as a unit of supply and through the other, G, H, to the fuel tank as an independent unit of supply. If either of the pipes J or M were stopped up, the water supply would cease but the fuel supply would continue. There is no mutual dependence of the two upon a single source of pressure governed by the air supply.

If we were to attempt to apply the literal words of patent Claim 13 to the defendant's torpedo it would

be necessary to change it at least in the following manner as indicated by italics:

> In apparatus for generating motive fluid for automobile torpedoes, a generating chamber D in which an oxygen carrier and fuel are burned and the products of combustion mixed with water vapor, a tank A for the oxygen carrier under pressure, a conduit B–R including a control valve C through which the oxygen carrier may pass to the generating chamber, a water supply O (but note in passing in what a different sense this word is used as the Government's supply is a tank of water and the patentee's supply is a device for pumping in water from the ocean), a fuel supply P, *a second conduit or pipe G–H and a third conduit or pipe G–J* likewise controlled by said valve and through which, *respectively*, the oxygen carrier is *delivered into contact with the fuel supply in P and the water supply in D*, and conduits N and M through which the fuel and water may freely pass *as displaced by the oxygen carrier* into the generating chamber, whereby the water and fuel feed depends at all times *upon the displacement effected by the volumes of oxygen carrier admitted to the containers.*

The thirteenth claim of plaintiff's patent does not in its terms read upon the defendant's structure. It is plain from the specification of the patent and from the other claims what the mechanism referred to by the words of the claim is, the *regulating* device, not present in the defendant's torpedo. (See also p. 124 above.)

This is not an emasculating construction of the claims or one which strikes down the plaintiff's patent and leaves it invalid. It leaves the claim and the patent covering a presumably valuable improvement embodying advantages emphasized by Davison in the specification, the use of a *single pump* or source of pressure independent of the low-pressure air for feeding water and fuel as a unit *without air coming into contact with the fuel* and the *regulation* or control of this pump or like device in accordance with any fluctuations in the *pressure* of the air supply.

There is no reason why the claims of plaintiff's patent should mean anything more than they say. Davison taught the art nothing new, his apparatus was a practical failure and reached even the stage of failure only long after the defendant's torpedo now complained of was a demonstrated success. He was anticipated in the theoretical art by Sodeau and his patents, and in the practical art he was long anticipated by the E. W. Bliss Company, which constructed the device of the Sodeau patents. On both grounds his claims must be limited and understood for what they clearly appear to state on their face, a device different from the Government torpedo which is the construction of the Sodeau patent published long before Davison's invention, embodying solely features of construction which the world learned from Sodeau and embodying none of the characteristic elements of the patented construction.

CONCLUSION.

1. As the Court below, after considering full and contentious evidence concerning the complicated subject matter, has found as a fact that the defendant does not use plaintiff's device, there is no possible error of law in the conclusion that plaintiff cannot recover.

2. The contract relates only to a specific device, Davison's "Steam Generator" as known by that peculiar name and as represented in the drawing alone considered by the parties in making the contract, and does not comprehend the widely different device previously given to the Government by the E. W. Bliss Company.

3. The scope of the contract, so far as based on the pending patent application, the tenor of which was unknown to the defendant and not considered by the parties, is determined by the actual novelty of that application and not by the terms of a claim granted later.

4. The patent and the terms of its claims do not cover defendant's device.

Respectfully submitted.

James M. Beck,
Solicitor General.

Robert H. Lovett,
Assistant Attorney General.

Harry E. Knight,

L. G. Miller,
Special Assistants to the Attorney General.

January 2, 1924.

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69468—24——11

ELECTRIC BOAT COMPANY v. UNITED STATES.

APPEAL FROM THE COURT OF CLAIMS.

No. 159. Argued January 11, 14, 1924.—Decided January 28, 1924.

Where the United States, without disclosure to it of the scope of an application for patent, obtained by a contract with the applicant a license, at certain rates, to manufacture and use the devices covered by the application, and was later sued by the licensor for its use of a device procured from another, which the licensor claimed came within his application and subsequent patent, *held:* (a) That the Government was not estopped from showing, by attendant facts and circumstances, that the contract was not intended by the parties to apply to the device so used, and (b) that a judgment of the Court of Claims, so limiting the contract, upon facts found, was not erroneous as a matter of law. P. 627.

57 Ct. Clms. 497, affirmed.

APPEAL from a judgment of the Court of Claims rejecting the appellant's claim, upon the facts found from the evidence.

Mr. Dean S. Edmonds and *Mr. Frederick P. Fish*, with whom *Mr. William H. Davis* was on the brief, for appellant.

A single question is presented, namely, whether or not the torpedoes constructed are within the patent, and therefore within the license and subject to the royalty payment provided for therein.

No question arises as to the validity of the Davison patent, because appellee is a licensee under the patent. *Eclipse Bicycle Co.* v. *Farrow*, 199 U. S. 581; *Harvey Steel Co.* v. *United States*, 196 U. S. 310.

The patent must be construed, particularly with respect to the claims indicated, to determine whether or not appellee's torpedo falls within it. This is a question of law to be decided by the Court. *Singer Mfg. Co.* v. *Cramer*, 192 U. S. 265.

Appellee's construction in all essential respects is identical with the construction of the Davison patent.

The only difference worthy of comment between appellee's and the patented constructions relates to the automatic regulator of the Davison patent. The characteristics attained by the use of the regulator were fully realized by Mr. Davison and were pointed out by him in his patent. But he realized also that these features were subsidiary to and refinements upon the general principle of making the feed of the fuel and water dependent upon the feed of the air so that the flow of all three of these ingredients would vary together, and that this principle could be utilized, as appellee has utilized it, by causing the air to act directly upon the fuel and water, just as well as by causing the air to act indirectly upon them through the intermediacy of a pump and a regulator, as is illustrated

in the Davison patent. This is made clear by the language of the patent.

This difference between appellee's and the Davison constructions is, therefore, a difference which has no bearing whatever upon the issues of this suit. It involves nothing more than the use, in the Davison construction, of an additional piece of mechanism to attain certain definite and additional advantages which are not attained with appellee's construction and to which the claims of the patent relied on in this suit are not limited.

A licensee is estopped from denying the validity of the patent covered by his license, and this is just as true when the licensee is the United States as when the licensee is an individual. *Harvey Steel Co.* v. *United States*, 196 U. S. 312.

But the principle goes further. The licensee is estopped from reading into a plain and unambiguous claim some element not actually present there, and from relying upon the prior art in support of a contention that such a construction of the claim is necessary. If a claim could be given some strained meaning and limited scope, out of all harmony with the usual and accepted meaning of the words employed and with the description of the invention contained in the specification, then the whole effect of the rule that the claim must be assumed to be valid because of the license, would be frustrated. *Eclipse Bicycle Co.* v. *Farrow*, 199 U. S. 581; *Siemens-Halske Elec. Co.* v. *Duncan Elec. Mfg. Co.*, 142 Fed. 157; *Chicago & A. Ry. Co.* v. *Pressed Steel Car Co.*, 243 Fed. 883; *National Recording Safe Co.* v. *International Safe Co.*, 158 Fed. 824; *United Printing Machinery Co.* v. *Cross Paper Feeder Co.*, 227 Fed. 600; *Leader Plow Co.* v. *Bridgewater Plow Co.*, 237 Fed. 376; *U. S. Frumentum Co.* v. *Lauhoff*, 216 Fed. 610.

So admission of the prior art on the ground that its examination is justified in order to fix the scope of the pat-

ent in suit (unless the claims of the patent are, on their face, ambiguous) is, in its practical effect, equivalent to releasing the defendant from the estoppel arising by reason of being a licensee under the patent or having assigned the patent to the plaintiff.

Refusal to examine and consider such extraneous evidence as the prior patents accompanying the findings would be particularly appropriate in this case in view of the special facts incident to the execution of the license.

In view of the simple facts and the plain language of the license agreement, the meaning of the agreement, what the parties intended to cover by it and what they actually did cover, are clear beyond the possibility of dispute. The thing which appellee was licensed to manufacture is explicitly defined, without ambiguity, at three places in the contract.

The correspondence leading up to the contract shows that a contract of just that meaning is just what the parties to the contract intended. Furthermore, that the parties understood that the Bliss torpedo was within the license covered by the contract is plainly indicated, for it was the only torpedo then in existence which had run a long range, the contract was solicited by the Department immediately after it had run the long range, the Department's attention was called to the fact that the Davison torpedo was "presumably similar to devices made by other companies," and that the Bliss torpedo was a water injection torpedo made by "proceeding along the same lines" as Davison, and, as soon as the license was in a form approved by both parties, the Department proceeded to order 50 torpedoes like the one which ran 10,000 yards on the test.

A representative of the Navy Department was informed of Davison's invention and urged him to develop it. Later, after much correspondence and negotiation, the Navy Department contracted with appellant and another

company for the manufacture of experimental torpedoes by them, and, as soon as the first of these experimental torpedoes was completed and tested, and its success in attaining a long range demonstrated, the license agreement now before the Court was negotiated and executed.

Throughout all of these proceedings, negotiations and correspondence, the Davison invention was referred to as the "Steam Generator for Automobile Torpedoes," and that was an entirely sufficient designation for it, because no such thing had been used before, and that term served adequately to differentiate from the superheater which had been in common use for years. The purpose of the license agreement was to secure to appellee the right to use the steam generator devised by Davison, regardless of any question either as to the validity of patents he might obtain or as to the scope of their claims. Appellee was not concerned with any such matters, and that is why it did not think it necessary to examine the Davison applications then pending in the Patent Office and in fact did not do so.

The invention was not anticipated in the prior art.

Mr. Harry E. Knight, Special Assistant to the Attorney General, with whom *Mr. Solicitor General Beck*, *Mr. Assistant Attorney General Lovett* and *Mr. L. G. Miller*, Special Assistant to the Attorney General, were on the brief, for the United States.

1. Since the court below, on the basis of all the evidence, has found as a fact that the defendant has not used plaintiff's device or invention, its conclusion that the plaintiff cannot recover presents no question of law the determination of which can lead to reversal.

2. The contract was for a definite physical thing—the Davison "Steam Generator for Automobile Torpedoes"—identified by and known to the Government only through a drawing or blue print. This device the Govern-

ment has not used, but instead it has used a device radically different in construction and operation, which device was made by the Bliss Company for the Government before the contract in question was made or was even suggested. *Harvey Steel Co.* v. *United States*, 196 U. S. 310; 38 Ct. Clms. 662; 39 Ct. Clms. 297.

3. The contract, in referring to a device covered by a patent application then pending in the Patent Office and not fixed in the form of a patent, and more especially since the content and tenor of the application was not considered by the parties, can be held at the most only to relate to what the parties could reasonably have expected to be patented; that is, to the actual novelty in the disclosure of that patent application, irrespective of the form of the claims which the Patent Office subsequently permitted in the patent document. *Eclipse Bicycle Co.* v. *Farrow*, 199 U. S. 581. In the present instance the Government utilizes devices not novel with plaintiff's assignor, Davison, but actual embodiments of inventions of the prior art which existed not only in the form of printed publications before the date of his invention, but which actually existed in the form of a completed torpedo built by the Bliss Company and successfully tested under Government supervision long before the contract was signed and even before negotiations leading to the contract were begun.

4. The patent in suit can not include and cover what was known to the public through a printed publication before the data of the patentee's invention and which the Government uses; and in fact it does not in its terms cover this.

Mr. Justice Holmes delivered the opinion of the Court.

This is a suit upon a contract made between the claimant and the United States on April 2, 1912. The contract,

headed "Shop License," recites that the claimant is "owner of the invention known as Steam Generator for Automobile Torpedoes covered by applications," of which it is necessary to mention only one, dated March 29, 1909; licenses the United States to manufacture and use torpedoes equipped with Steam Generators covered by the application to the end of the term for which patent may be granted; and binds the United States to pay at certain rates for such torpedoes. The claimant alleged that the United States had used the devices covered by claims 1, 5 and 13 of letters patent issued upon the above application on August 20, 1912. The Court of Claims found that those devices had not been used by the United States, but that the mechanism actually used by it was practically identical with that of a rival, the E. W. Bliss Company, that had been successfully tested in the fall of 1911, before the date of the above contract and before the plaintiff had attempted but failed to satisfy the same tests.

When this contract was made the United States had not seen the applications, which were the claimant's secret. Both parties knew that the Government was dealing also with a rival concern, and the United States, at least, and probably the claimant, knew that the rival had satisfied the Government's tests, which the claimant had not then done. It could not be believed that the contract meant a blind acceptance of liability for whatever might be in an undisclosed document. It did not; what it aimed at was a specific device which it was given to understand had been invented. We do not argue this at length because the proposition is accepted by the claimant—"the purpose of the license agreement was to secure to appellee the right to use the steam generator devised by Davison, regardless of any question as to the validity of patents he might obtain or as to the scope of their claims." The dealings began with proposals for applying a system to existing torpedoes that would double their range, illustrated by a

drawing showing the general arrangement of the device, identifying it but not disclosing it in detail. They ended in the contract, which went further, but undoubtedly had reference to a system the general nature of which was understood.

We must take it on this record that, at the time, certain elements in the construction of self-moving torpedoes were well known. The front end contained the explosive. Behind that was a chamber of compressed air that was transmitted to an engine moving the propeller through a pipe with a valve that reduced the pressure of the condensed air to the desired point and kept it constant The moving force was enhanced by heating the air after it left the valve. This was done by passing it through a combustion chamber into which was forced alcohol or other fuel. The fuel was in a third chamber and was carried to the place of combustion by the condensed air through a second pipe from beyond the reducing valve. It was ignited when the shell was launched. More was needed to carry the torpedo the distance required to make it usable in modern warfare. It was understood that the result could be accomplished and danger to the contrivance from excessive heat avoided by the introduction of water into the combustion chamber where it would become steam. The Bliss Company had given this knowledge a practical form, and there is no warrant in the record as it comes to us for suggesting that the claimant had anything to do with the Bliss Company's success, or that the Government had any reason for thinking that it had. In deciding what the Government reasonably supposed that it was buying, these facts are important, and what may have been contained in the undisclosed application is of little or no weight. Whatever may have been the rights of the claimant as against the Bliss Company, the Government was entitled to assume that they did not extend to the above elements, separately or combined.

Manifestly, on these facts, the Government is not estopped to show that its contract applied only within narrow limits. If the facts were as it had a right to suppose them to be, the contract necessarily was so limited. The Government thought that it might be that the claimant had found a more perfect way to do what was wanted and what the Bliss Company already had done, but, on the record before us, it would be monstrous to suppose that it was undertaking to pay the claimant for the Bliss Company product. The claimant was thought by the Government to have failed in its undertaking, and therefore its device was laid aside. That device had certain peculiarities not repeated by the Bliss Company's, but the claimant relies and has to rely here upon the broad contention that the introduction of water to the combustion chamber in an effective way belongs to it, which seems unlikely in view of the previous British patent to Sodeau, in 1907, and others, and which it seems to us clearly might have been found, as by implication it was found, by the Court of Claims, not to have been the assumption or the meaning of the contract. So far as appears, the use of water by the Bliss Company owed nothing to Davison, the claimant's assignor, but very closely embodied the suggestions of Sodeau and other predecessors in the field. We cannot say as matter of law that the Court of Claims was wrong.

Decree affirmed.